SCIENCE

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FRIDAY, NOVEMBER 15, 1929

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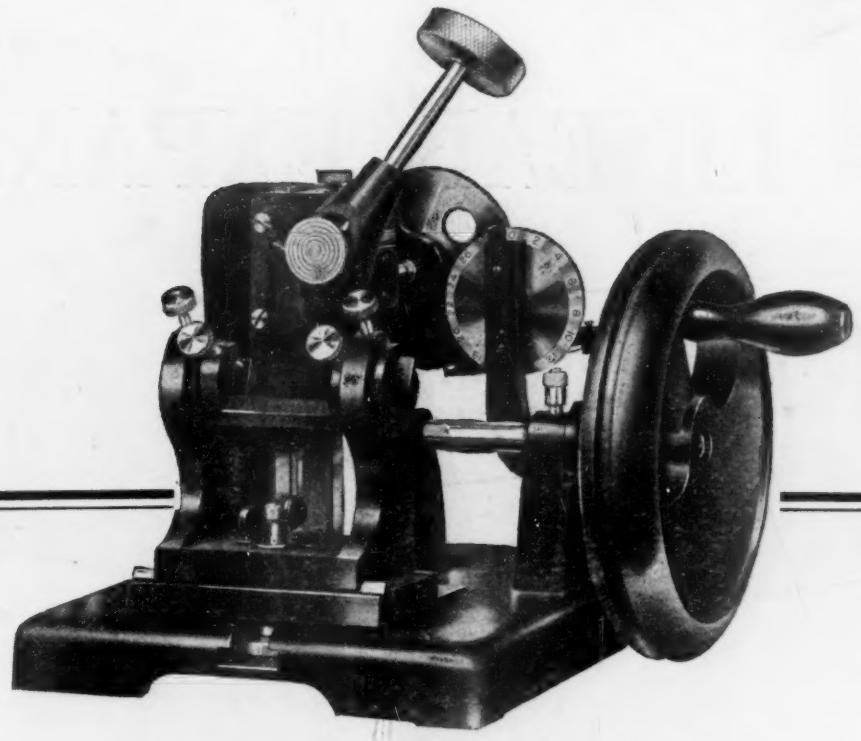

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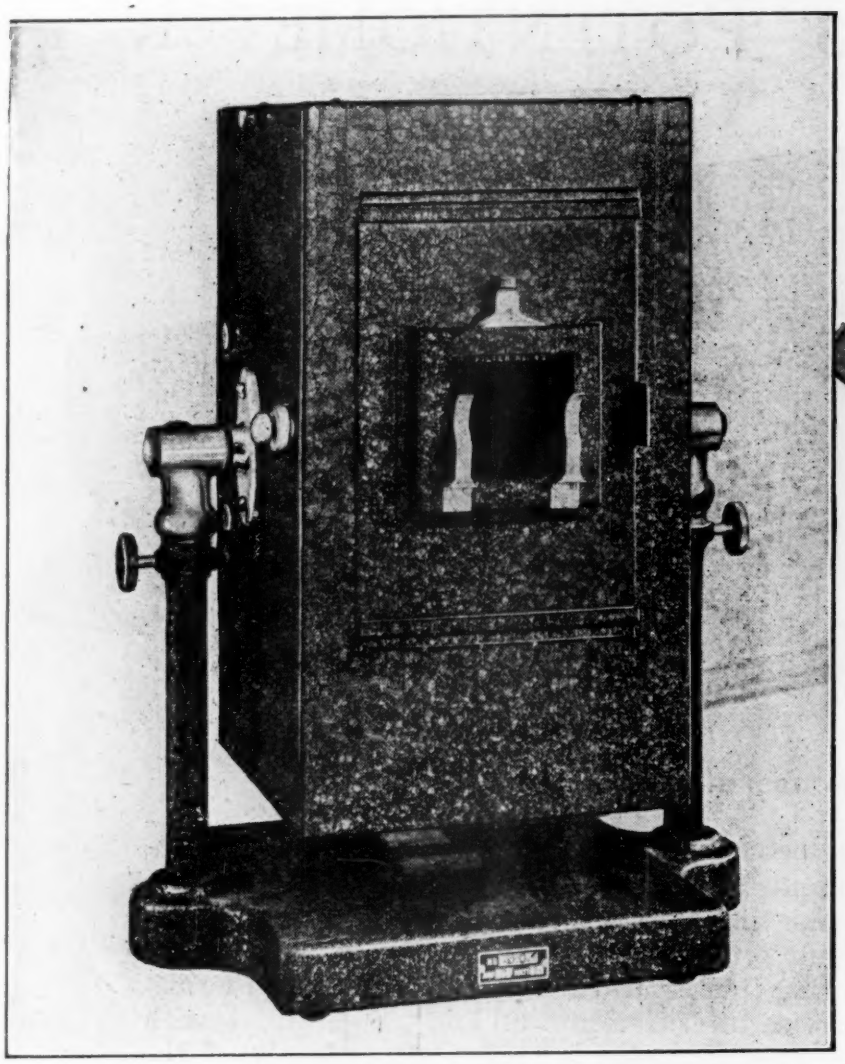

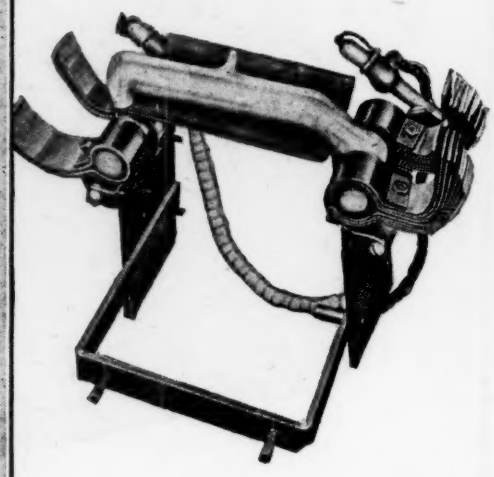

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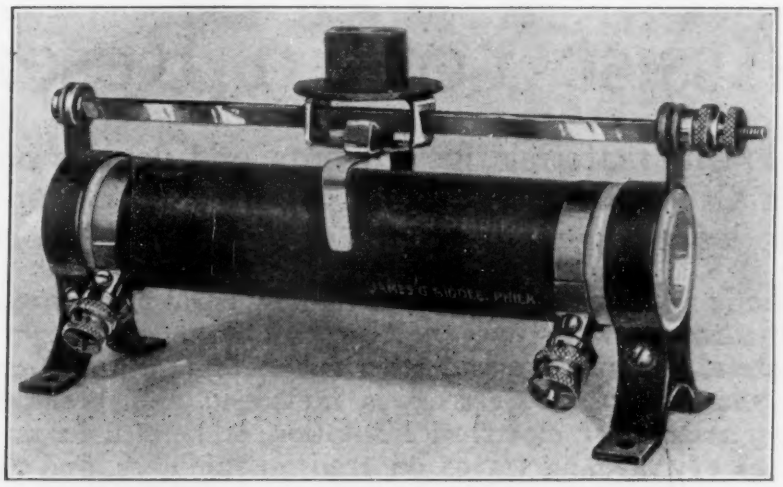

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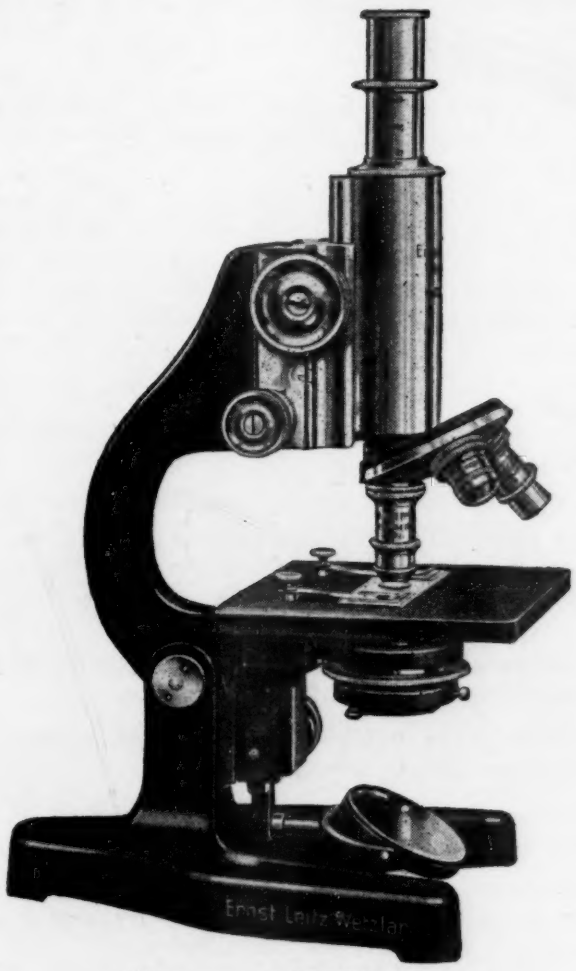

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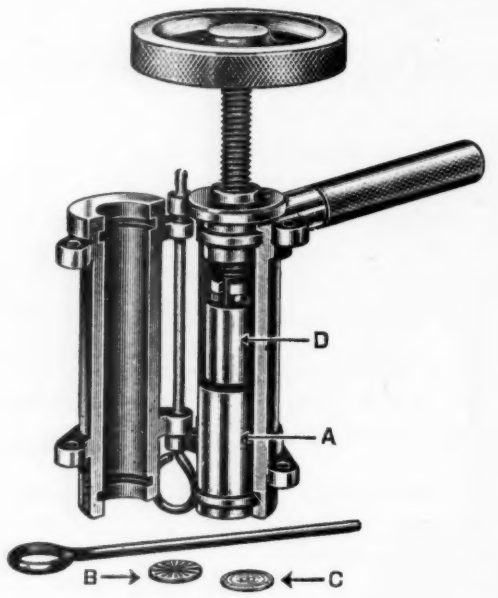

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THE INSTRUMENTS OF PLANT BIOLOGY[1]

By Dr. H. A. SPOEHR

CARNEGIE INSTITUTION, STANFORD UNIVERSITY

RESEARCH and teaching are the warp and woof in the complex fabric of education. The necessity of adjustment to the new world which scientific thought is creating is the joint responsibility of the teacher and of the researcher. Institutions devoted to research, in order to remain virile, must from time to time reexamine their aims and objectives and effect a restatement of their program in conformity with the advancement produced by their own efforts and with that of modern thought. The dedication of this building marks another step in the progress of biological science in the Carnegie Institution of Washington.

Our institution has since the inception of its activities supported various research projects in the plant sciences. These have been devoted mainly to special problems, and from time to time new projects have been undertaken which were organized either independently or in conjunction with existing ones. In 1928 the Division of Plant Biology was formed to embrace all these projects operating in the western United States, with the view of facilitating cooperation between the workers in these groups and with other activities of the institution, for the unification of research programs and of administrative arrangements and to provide a basis for future development.

The Division of Plant Biology is thus composed of a number of sections constituting relatively small groups of workers who are devoting their attention to special projects. These sections are located according to the requirements of the particular scientific problems under investigation.

Portions of the western United States are of inestimable value for intensive study of the natural proc-

[1] Address at the dedication of the central laboratory of the Division of Plant Biology, Carnegie Institution of Washington. This building is located on the campus of Stanford University, and dedication exercises were held August 27, 1929, Dr. Henry S. Pritchett, vice-chairman of the board of trustees of the Carnegie Institution of Washington, presiding.

esses and successions of large plant communities, because here these still exist undisturbed by the direct and indirect influences of man. These virgin areas make possible the study of the factors and conditions which are determinative for the existence of specific biologic units.

The Desert Laboratory, at Tucson, Arizona; the Coastal Laboratory, at Carmel, California; the Alpine Laboratory, on Pike's Peak, Colorado, and a number of experimental bases at several places in the western United States offer unusual facilities for the investigation of problems in which particular organisms, the climatic complex or edaphic conditions play an important rôle. It is the aim of the division that the laboratory investigations at these stations supplement the field studies for which the locality offers special opportunity.

We now have a central laboratory for work on some of the more general problems which require more elaborate laboratory apparatus and equipment. This laboratory offers opportunity for the development of more effective correlation and unification of effort of the outlying stations. The site of the present developments includes five acres of land leased from Stanford University by the Carnegie Institution of Washington, and the provisions of the lease make it possible to increase this up to twenty acres as occasion requires. These developments embrace the laboratory building of reenforced concrete construction, the adjoining preparation house, the glass-house, with head-house and the transplant and culture gardens. In the basement of the laboratory are facilities for optical and photochemical work; here are also the shop, heating plant and ample space for storage. The first floor is equipped for biochemical investigation; on the second floor are the library, the laboratories for experimental taxonomy and cytological work in connection therewith, and two smaller laboratory rooms. The preparation house has been built for use in the isolation of physiologically important compounds. This work entails the handling of relatively large quantities of plant material, large amounts of highly inflammable solvents and the use of noisy machinery. Therefore, it was deemed best to locate this work in a separate building. The development of the transplant gardens and greenhouse has permitted the transfer here of practically all the perennial coastal transplants heretofore temporarily held at other stations. For investigations entailing the culture of plants, either in the open or under glass, the conditions on the Stanford campus are exceedingly favorable. The laboratory as well as these gardens are also offering the opportunity for undertaking here cooperative experimental studies on several basic problems in connection with members of other scientific institutions in different parts of the world.

As Millikan has stated, "A science, like a planet, grows, in the main, by a process of infinitesimal accretion . . . each new theory is built like a cathedral through the addition by many builders of many different elements." If this be true of the relatively simple and severe structure of physics, it is even more so of the tremendously intricate science of biology. The biologist is confronted with such a multiplicity of phenomena and with such a diversified aggregation of physicochemical systems that he can hope to build a sound and well-grounded structure only through the contributions of a variety of craftsmen.

The chemist and physicist have detected and studied the forces with which they are dealing by means of instruments of their own construction. The deflection of a galvanometer indicates the flow of an electric current and its use has taught us much of the nature of electricity. But such knowledge as we now have of the nature of electricity has been gained through the correlation of observations from various systems or instruments designed to manifest electrical phenomena. This knowledge would be very limited if the physicist and chemist had confined themselves to the movements exhibited by the galvanometer or to its construction and material composition, significant as these are.

The biologist is primarily interested in the forces of organic nature. Manifesting these forces are the multitudinous forms of plants and animals. These are the biologist's instruments, for they alone exhibit the phenomena which are the center of his interest. It is the initiation, correlation and succession of the changes manifested by his instruments which he is endeavoring to understand. It is our aim to approach the problem of interpreting the manifestation of life forces from various angles. The behavior of plants under natural and controlled conditions, their detailed description and orderly arrangement, their physical components, their chemical composition and the physical and chemical forces involved in their functioning all contribute, when correlated, to the same fundamental problem. The biologist is not unmindful of the fact that his conceptions of life processes are limited and that he is still using largely empirical methods. The discovery of the *mechanism* in any of the complex of functions of a living organism, even when described in terms of physics and chemistry, is not the real base of the problem, no more than the swing of a galvanometer reveals the nature of electricity. Yet the description of mechanisms must ultimately contribute to the solution in the same manner that the highly technical and involved experiments of the physical sciences have contributed to an understanding of the nature of electricity.

Obviously every phase of plant science can not be intensively and adequately pursued within a single

organization. It is our aim to concentrate upon a few problems of fundamental significance and, with the careful recasting of research programs, to correlate aims and unify effort. On this basis the work of the division is to be conducted in relatively small and elastic units, the particular needs of the investigations determining the organization of personnel and equipment.

At the present time a number of fundamental problems are being approached in different localities and from different view-points. The series of investigations centering at the Alpine Laboratory and the field stations at Santa Barbara has resulted in an interpretation of the development of vegetation in which plant complexes are treated as organic units which have developed in response to environmental conditions. This method stresses the importance of dealing with the biotic community as a unit instead of treating plant communities as separate entities. From such a view-point it may be possible to gain a broader prospect of plant aggregates as the result of many involved and mutually interacting influences. Thus the complex of climatic and edaphic environment, regular and cyclic, over periods of time is expressed in the nature of the vegetation.

We can at best see but a very brief span in the life history of most of the existing plant societies. What they are to-day is to a large measure the reflection of past experiences. The studies in paleobotany which are being carried out within the division have helped to explain certain peculiarities of distribution which, for example, characterize the modern forests of western America. The fossil record of the redwood indicates that it was formerly distributed over most of the northern hemisphere, including Manchuria and Siberia. The influences which have brought about the greatly restricted range of this tree at the present time seem to be related to changes in climate. The physical history of the past and its influence on plant developments are thus being revealed by the study of fossils.

The arid regions of North America are characterized by certain extremes in climatic and edaphic conditions and consequently present many highly specialized and diversified forms of life. The relation of these conditions to the physiological behavior, distribution and evolutionary history of the flora has constituted most of the work that has been pursued at the Desert Laboratory. Very marked differences in the relations to the environment are exhibited by different species of desert plants, indicating divergent adjustment to external conditions and frequently diverse physiological behavior. This has been followed more particularly in the water economy of desert plants through both laboratory and field investigation. Observations on the establishment of new individuals, on the course of their developments and on the precise changes in the composition of vegetation have been carried on continuously over a period of many years. Correlated with laboratory experiments and anatomical studies, measurements of growth have been made on a variety of plant forms. These measurements, especially on trees, in different habitats, have now been made over extended periods of time.

With the object of contributing to the portrayal of the natural methods or processes which in the past have been operative in organic evolution, an elaborate series of experiments is in progress extending through the great range of natural conditions from the Pacific Coast line over the Sierra Nevada. Taxonomic questions, raised by herbarium studies and involving the characters commonly used in classification in prominent groups of our larger western American plant families, are subjected to experimental and statistical test wherever practicable. The methods are of the transplant type and, briefly, consist in moving diverse but closely related forms into a uniform environment and of moving a single form into diverse environments. These experiments, centered at this station and pursued at five field stations of decidedly different climatic complex, are arranged to give information regarding the stability or flexibility of different plant characters, particularly those which are the criteria used in plant classification. Experimental methods are also being developed to distinguish between fixed characters and temporary modifications resulting directly from environmental influences.

There has been a wide-spread and constantly growing movement in biology to attempt to resolve the complex phenomena of organic nature into simpler systems and mechanisms which permit of exact treatment. This movement has its roots in a deep-seated, though often not frankly recognized, faith; a faith that biologic phenomena are amenable to the same rigorous treatment of experiment and reason that has yielded such marvelous results in physics and chemistry. As Whitehead has stated: "Faith in reason is that trust that the ultimate natures of things lie together in a harmony which excludes mere arbitrariness. It is the faith that at the base of things we shall not find mere arbitrary mystery." Historically considered, we are only at the beginning of this movement in biology. It is only within the past half century that the sum total of knowledge in chemistry, which is essential before applications can be made, has grown to sufficient proportions to make such an undertaking promising. And there are still enormous gaps in the systematic knowledge as well as in the

broader conceptions which must be filled before chemistry and physics can serve as a language to express the phenomena occurring in living things. This is the highest function which these sciences can serve. To undertake the reduction of the great heaps of biologic observations and classification to some rational system is a task which the orthodox physicist and chemist have apparently deftly avoided.

The science of organic chemistry had its origin in the study of the chemical compounds constituting living organisms. This led to problems of the constitution of highly complex carbon compounds and thence to the fruitful era of synthesis of organic compounds, resulting in the artificial production of many substances previously obtainable only from some living organism. During this period plant chemistry pursued mainly those courses which led to substances useful as food, as drugs or in the arts. Recently there has been a marked reorganization in the realm of organic chemistry. On the one hand, problems of chemical kinetics, of structure and of valence have clearly resolved into physical chemistry, and on the other, backed by a century of experience in carbon compounds, the organic chemist is again turning to the chemistry of the living organism. He is now concerned not only with the substances which may be derived from living organisms, but primarily with those substances which play a rôle in the manifold *processes* of the organism and with these processes and reactions themselves. To those who lay emphasis on nomenclature and the artificial demarkations of science he may have become a biochemist, but his modes of attacking a problem remain those of the chemist. He has retained and fostered his valuable alliances with the exact sciences of physics and mathematics. This fruitful, unifying and correlating tendency so noticeable in physics and chemistry is gradually also permeating biology. It forms the basis of a newer faith, the understanding of which grows through application.

Synthetic organic chemistry has just celebrated its hundredth anniversary. Among its achievements is the production of many substances which formerly could be obtained only from a living organism. While this was unquestionably a great advance in knowledge, it is not improbable that it will some day be regarded as a detour on the highway of organic chemistry. Incidentally, the business of the farmer and forester may be materially influenced by the fact that a not inconsiderable portion of their products will take the form of raw materials for further transformation by chemical processes rather than by simply raising the field crops or trees as at present. But thus far organic chemistry has contributed relatively little to the really fundamental problem. The interconversion of the multitudinous organic compounds has familiarized us with their properties and certain general principles of carbon compounds. *Yet the basic problem remains.* This is not the synthesis of cane sugar, proteids or fats from other organic or even inorganic materials through the drastic methods of organic chemistry, but rather *how* these substances, and ultimately also coal and petroleum, are formed in nature from carbon dioxide, water and ammonia.

These steps are far more difficult and progress is apt to be much slower than in the past era. One of the first requirements is more precise knowledge of the physical and chemical composition of our apparatus, the plant; that is, the minute physical structure and chemical nature of the systems with which we are dealing. Is it not idle to speculate regarding the processes taking place in plant cells when we have but the most rudimentary knowledge concerning the materials of which the cells are constituted? The masterly researches to which Thomas B. Osborne devoted the entire scientific activity of a long life have resulted in our knowing but a small fraction of the nitrogenous components of plant cells. Yet this knowledge constitutes one of the very few sound foundation stones of plant physiology. Until we are more thoroughly familiar with the structure and composition of the instruments which manifest the forces the nature of which we are striving to reveal our quest must needs be empirical and fragmentary.

In order finally to understand the functioning of plants and their behavior in the great complex of natural environmental influences these functions must be resolved into processes the kinetics of which can be interpreted in terms of physics and chemistry. But this task constitutes a great deal more than applying existing techniques and conceptions of physics and chemistry. Supported by the latter, the biochemist must analyze systems and interpret reactions for which no exact counterpart has as yet been found in inorganic nature. We need but refer to certain enzymatic reactions, those of amorphous "mass molecules" and to photosynthesis.

Probably no one who has spent years in an active struggle with these problems would venture the opinion that in such a method or attitude of mind we have an open sesame which will throw wide the portals of life. Experimental biology has never been favored with methods or means of approach to its problems which permit of apodeictical statements. Yet in the vast majority of biological phenomena we are sooner or later brought squarely to face problems dealing with changes of state and transformation of materials which are clearly of a physical or chemical nature

and for the solutions of which only physical and chemical conceptions apply. Even though the application of physical and chemical methods may not at once reveal the ultimate nature of life processes it constitutes an essential step in an interpretation of the dynamics of biological phenomena.

In conclusion, I wish to express, on the part of my colleagues and myself, the sincere appreciation of the thought and painstaking interest which President Merriam has given to the development of the organization and plans of this division, of the liberal support of the trustees of the Carnegie Institution and of the opportunity and splendid cooperation given by Stanford University.

SURFACE STRUCTURE AND ATOM BUILDING. II

By Professor W. D. HARKINS

UNIVERSITY OF CHICAGO

(5) *Graphical representation of the new periodic system.* A complete atom contains as many electrons as protons. If the weight of one proton (p) plus one electron (e) is taken as unity, then the atomic weight (W)[9] is supposed to give the number of protons and of electrons in the atom. That is, the symbol $(pe)_W$ represents the composition of any complete atom of atomic weight W. If P is the number of protons in the atom, then P = W. Let N represent, not the total number of electrons in the atom, but the number in the nucleus, then P − N = Z is the *atomic number,* and 2N − P is the *isotopic number,* for any known or unknown atomic species.

An entirely new periodic system was revealed when two of the above variables were plotted on a two-dimensional diagram, but by far the simplest form of this system was found to be given with the isotopic number on one (Y) axis, and the atomic number on the other (X) axis. If even numbers are represented by heavy lines, and odd numbers of these variables by light lines, an extremely remarkable pattern is found to emerge (Fig. 8).

The isotopic number for any atomic species other than hydrogen gives the number of the isotope according to a system in which the lowest possible isotope of any element is given the number *zero.* For example the isotopic numbers for the known species of a few elements are: He, 0; Li, 0 and 1; Be, 1; B, 0 and 1; C, 0; Mg, 0, 1 and 2; Al, 1; Si, 0, 1 and 2; Fe, 2 and 4. If the empirical formula of any nucleus is written $(p_2e)_s$ $(pe)_n$, then the subscript n gives the *isotopic number,* just as the subscript Z gives the atomic number.

The isotopic number is as important to distinguish the species as the atomic number to distinguish the element.

[9] Actually W is very close to, but in general is not exactly, a whole number. P is this whole number.

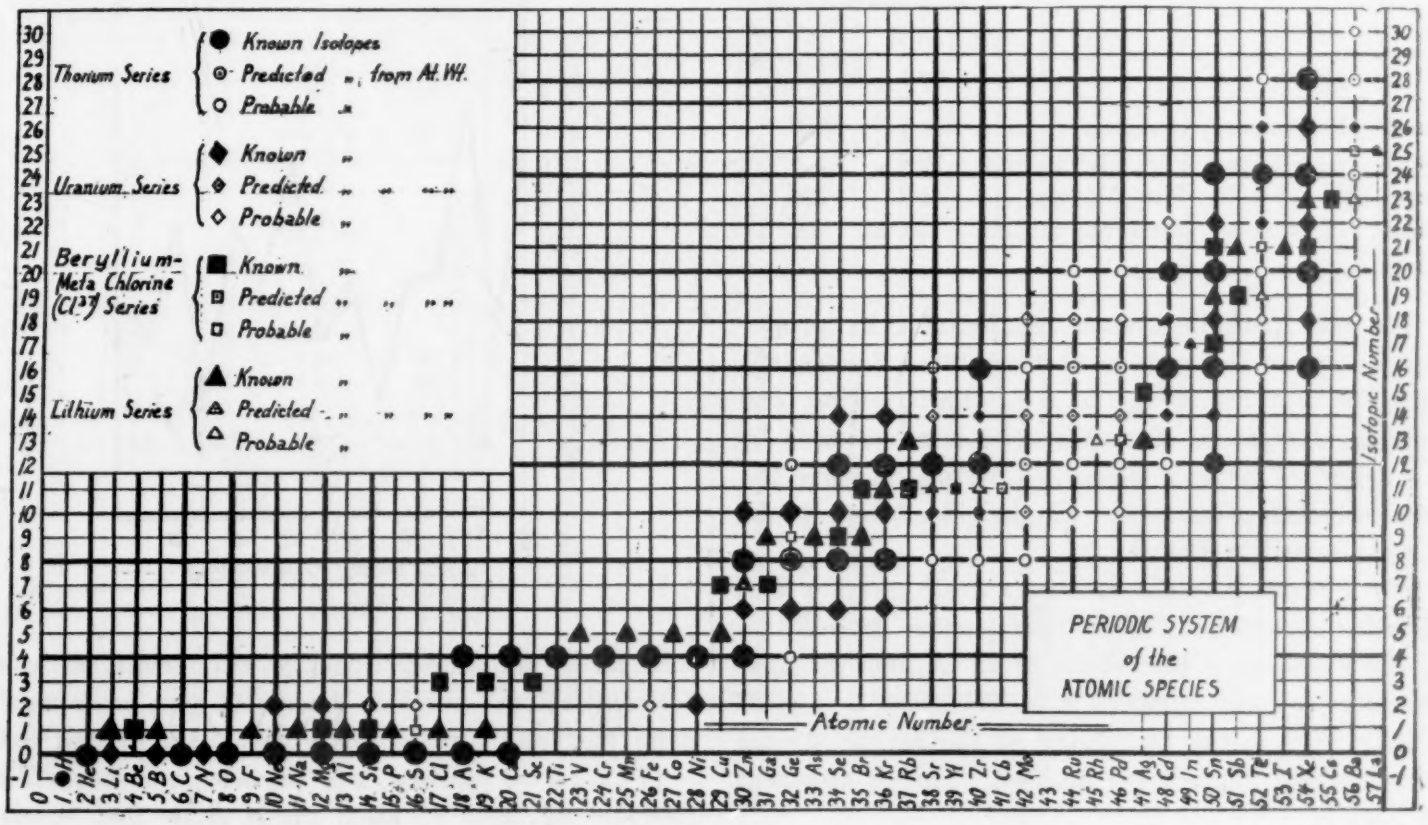

FIG. 8

As has been stated the *heavy coordinates in Fig. 8 represent even numbers and the light lines odd numbers.* Now it is remarkable that where heavy lines meet heavy lines the greatest number of species occur (sixty-seven known species in the figure), and these are also by far the most abundant. Where light lines intersect light lines the number of known species is less (thirty-two), and the atoms of these species are in general far less abundant. Where heavy vertical lines intersect light horizontal lines the number of known species is again reduced by about one half to fourteen species.

By far the fewest species occur where light vertical meet heavy horizontal lines (Class IV). It is indeed remarkable that only three species (Li_o, B_o and N_o) of this type are known in the whole system of 92 elements, and it is even more remarkable that all three lie on the *lowest heavy* line of the diagram, that of isotopic number 0. If their production were governed by pure chance, 1 atom in 4 should belong in this class, while actually it contains only 1 atom in 160,000 in the earth's crust. Thus *there are almost no atoms in which the number of nuclear electrons is odd and the number of protons even.* Thus there is a certain matching of P and N. Thus if N is even, P is usually even, and if N is odd, P is almost always odd.

TABLE I

CLASSIFICATION OF ATOMIC SPECIES ACCORDING TO EVEN AND ODD NUMBER OF ELECTRONS

	Abundance in atomic percentage	
	Earth's crust	Meteorites
Class I, N = even, P = even, z = even	87.4	95.4
Class II, N = even, P = odd, z = odd	10.8	2.1
Class III, N = odd, P = odd, z = even	1.8	2.5
Class IV, N = odd, P = even, z = odd	0.0007	0.0

The new periodic system requires for its proper representation a figure in at least three dimensions. Suppose that Fig. 8 lies in a horizontal plane, and that the abundance of each species is represented by the height of a peak which lies vertically above the point which represents it. The height of these peaks is represented in Fig. 9.

(6) *Fourth periodic relation: high stability and abundance for atoms of isotopic number divisible by 4, and a secondary periodicity of 2.* Among the light elements (atomic numbers 6 to 28) there is a periodicity of 4 in the abundance of the atomic species as related to the isotopic number. This is apparent in Fig. 9.

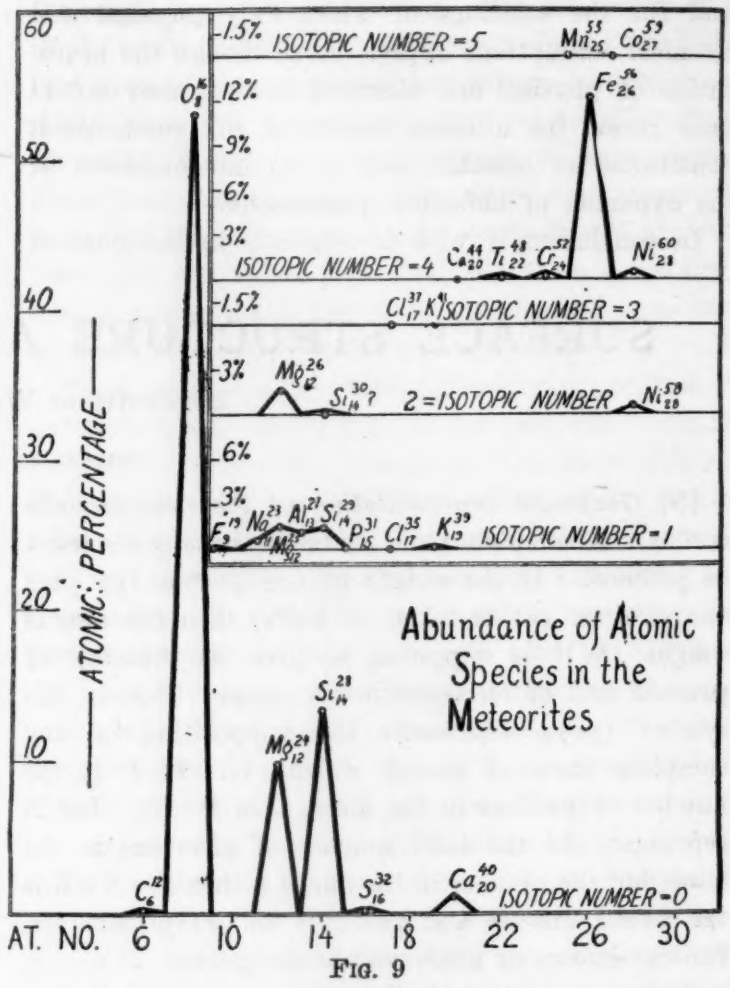

FIG. 9

Furthermore, as is shown plainly by Fig. 10, there is a periodicity of 2 in the *number of species now known* with respect to the isotopic number. The appearance of the plot represented by Fig. 8 seems

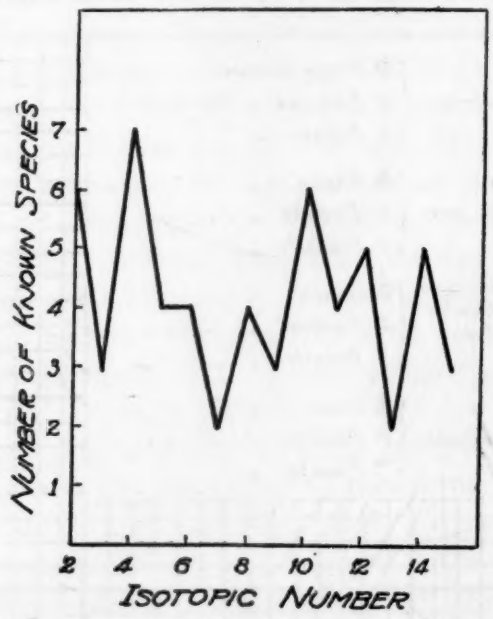

FIG. 10

to indicate that this periodicity will remain, at least between isotopic numbers 2 and 10, even after much more thorough investigations have been carried out.

(7) *General theory of nuclear stability.* The periodic relations of atom nuclei show that special

types of composition with respect to evenness and oddness of number are very much preferred to others, and that evenness of number is much the more common.

There is in addition a general, non-periodic relation which determines the general bounds of the region of atomic stability.

First, no nucleus (other than the proton) is known in which the ratio of electrons to protons (N/P) is less than ½ or 0.5.

Second, the net positive charge on the nucleus of an atom may rise as high as 20 while the relative negativeness (ratio of negative to positive electrons) remains at its most general value of 0.5, but in order that the nucleus may be stable and attain a higher net positive charge, the relative negativeness must increase to an extent which increases with increase in the net positive charge. Thus the atom nucleus, in order to be stable, must have a relative negativeness (N/P) which matches its net positiveness (Z).

The band of stability is shown in Fig. 11. It is of great interest that the small number of atomic species contained in the rectangle in the lower left-hand corner of this figure constitute 99.9 per cent. of all known material.

The usefulness of the relationship between stability and the relative negativeness (N/P) of the nucleus is illustrated by the fact that before the discovery of the isotopes of lithium four predictions were made by various workers concerning their existence, and the only one of these found to be correct was that made on the basis of this relation.

If the nucleus of the atom is considered as consisting of an aggregation of positively charged groups, then by the principles of electrostatics alone a mutual repulsion is to be expected. This indicates that other, probably magnetic, forces are involved. However, there might well be limits beyond which such forces could not go in holding positive groups together. It is well in this connection to consider certain facts:

a. The most abundant atomic species are those in which $\frac{N}{P}$ is ½.

b. No atomic species for which $\frac{N}{P}$ is equal to ½ has a positive charge on the nucleus which is greater than 20.

c. All atomic species of nuclear charge greater than 29 are very rare. According to the data less than one atom in a thousand has a nuclear charge higher than 29.

If it is assumed that the positive groups in atom nuclei exhibit a certain amount of mutual electrostatic repulsion, which increases with the positive nuclear charge Z, then it may also be assumed that with nuclei for which Z is large, this repulsion may be

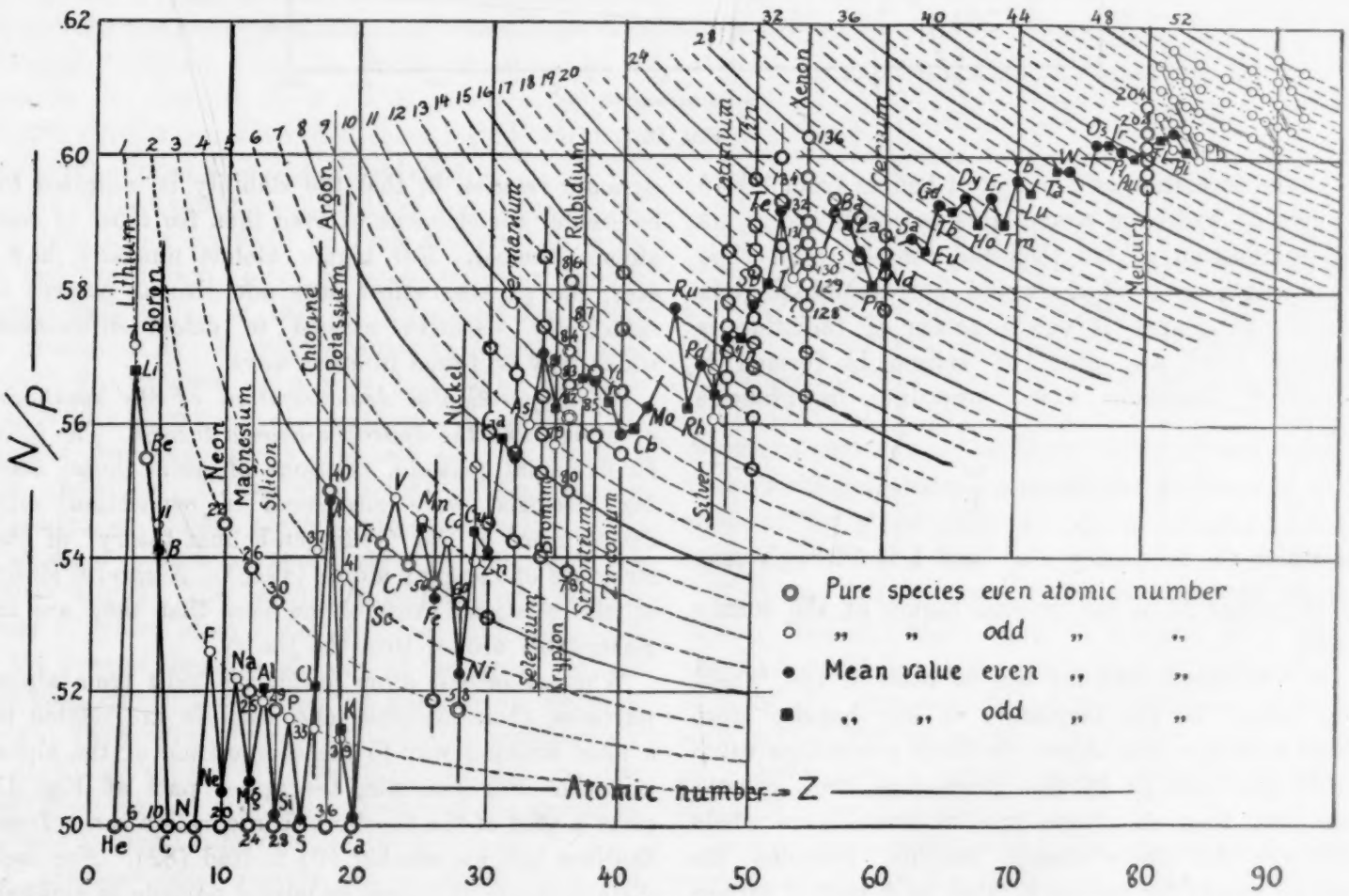

FIG. 11

decreased by an increase of $\frac{N}{P}$, the relative negativeness of the nucleus.

(8) *The whole number rule and the packing effect in the formation of complex atoms from hydrogen.* If four atoms of hydrogen unite to form one of helium, then atomic mass is lost in the process. The amount of this mass which thus disappears is equal to 0.76 per cent. of the mass of the hydrogen utilized. The amount of energy which thus escapes, presumably as energy of radiation, was calculated by Harkins and Wilson (1915) as 2.8×10^{-19} ergs per 4 g of helium formed, by the use of Einstein's equation,

$$-\Delta E = -c^2 \cdot \Delta m$$

in which $-\Delta E$ is the energy loss in ergs, $-\Delta m$ the loss of mass in grams and c the velocity of light.

If the packing effect is almost constant, the true atomic weights on the basis of oxygen as 16 must be very close to whole numbers. This rule (Harkins and Wilson, 1915) is commonly known as the "whole number rule."

If the energy of emission of alpha and beta particles in radioactive transformations comes from the nucleus itself, then the packing effect should increase as the complexity of the nucleus decreases. Harkins and Wilson considered, however, that the evidence of the chemical atomic weights indicated that the departures from whole numbers are not in general over 0.1 per cent.

Recent work by Costa and by Aston indicates that, as is to be expected from the above considerations, there is a maximum for the packing effect, and it is found to occur at atomic weights between 50 and 80.

The values (Fig. 12) for light elements of odd and even number exhibit agreement with the *second periodic relation* in that the stability is indicated to be greater for elements of even than for those of odd atomic number. For higher atomic numbers, however, the packing effect does not give at present a sufficiently sensitive method to detect differences which may be found in other ways.

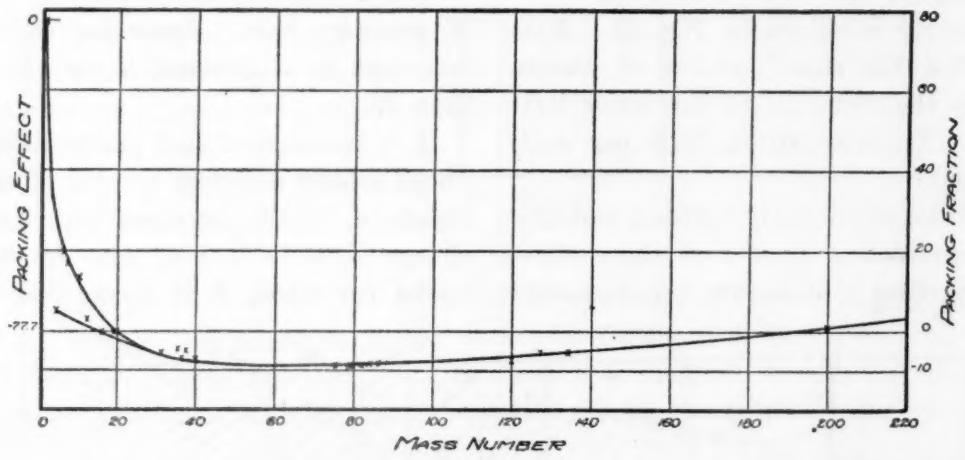

FIG. 12

Thus the formation of 1 pound of helium from 1.0078 pounds of hydrogen would give as much energy as the combustion of ten thousand tons of coal. The wave-length (λ) which would correspond to this amount of energy if one quantum of radiation is emitted when one atom of helium is formed is 4.3×10^{-4} Ångstrom units, according to Planck's law:

$$E = h\gamma = \frac{hc}{\lambda},$$

in which the frequency $\gamma = \frac{c}{\lambda}$ and h is Planck's constant. This is in the general region of the cosmic rays.

It was found that the loss of mass or the "packing effect" in the formation of any heavier atom from hydrogen has almost the same percentage value (0.76 per cent.). If this percentage were exactly constant, then all atomic species would have whole numbers for their atomic weights, provided the atomic weight for helium is taken as 4, that of carbon as 12, that of oxygen as 16, etc.

(9) *Experimental demonstration of the synthesis of atoms, and the hydrogen-helium theory.* The four fundamental periodic relations of atom nuclei thus far discussed were discovered in connection with development of the "hydrogen-helium theory" of the structure of complex atoms (1915). A careful study of the relations exhibits the fact that they are in remarkable accord with the theory.

Whether or not atom nuclei are built from alpha particles, their existence and stability are related in a most striking way to the composition of the alpha particle. For example, the upper part of Fig. 13 gives a plot of the thorium disintegration series from thorium (atomic number 90) to lead (82). For each disintegration in which an alpha particle is emitted, the atomic number is lowered by 2.

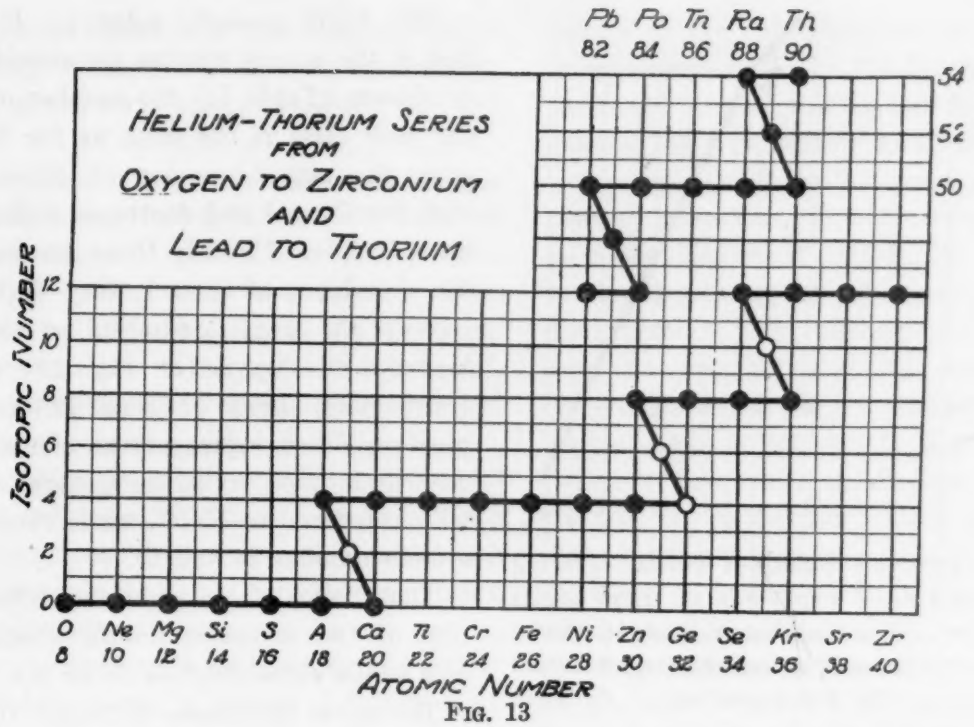
Pb Po Tn Ra Th
82 84 86 88 90
HELIUM-THORIUM SERIES
FROM
OXYGEN TO ZIRCONIUM
AND
LEAD TO THORIUM
ISOTOPIC NUMBER
0 2 4 6 8 10 12
54
52
50
O Ne Mg Si S A Ca Ti Cr Fe Ni Zn Ge Se Kr Sr Zr
8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
ATOMIC NUMBER

FIG. 13

The lower part of the figure shows the lower end of the same series in which no disintegrations have been found to occur. It is, indeed, extremely worthy of attention that the lower part of the series for ordinary atoms exhibits the same pattern as that for the radioactive elements. Thus only the species of even atomic number are found in either series. The plot of the series for low atomic numbers shows that no species of odd atomic number which belongs on one of the horizontal lines has as yet been discovered, although there are vacancies which correspond to 20 species. In contrast, 22 of the 23 positions for even atomic number are filled, and these include the most abundant species of atoms which exist.

One of the evident suggestions of this figure is that the light atoms are built up from helium. In order to test the helium theory of atom building, experiments were begun in 1921 by Ryan and the writer to determine by the photography of Wilson Cloud tracks what occurs when very fast alpha particles collide with the nucleus of the atom. The method thus applied was adopted by Blackett and by Harkins and Shadduck. It was shown that in some of the collisions an alpha particle attaches itself to the nucleus of a heavier atom and thus increases the atomic weight. This is the only synthesis of a heavier from a lighter atom which has been observed. Up to the present time the addition of the alpha particle has been demonstrated only in the case in which a proton (hydrogen nucleus) is almost simultaneously emitted. However, this limitation is due to the method employed, since the emission of the hydrogen particle is used as the test for the synthesis.

If the fast alpha particle merely collides with the nucleus of the heavy atom, a fork is obtained (Fig. 14 *A*). If the alpha particle collides with the nucleus at b (Fig. 14 *B*) and adheres to it, the photograph shows only a straight line which is

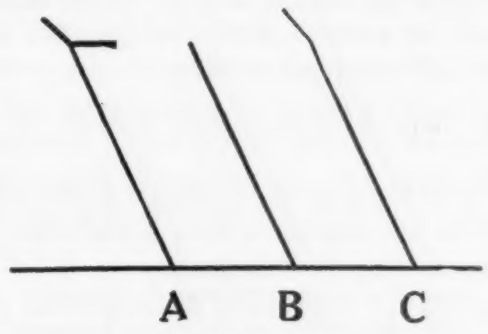

FIG. 14 A, B, C

exactly like the track of the alpha particle, except that it is shorter. It is extremely difficult to prove that the track has not been shortened by some other cause. If, however, the alpha particle adheres, and a hydrogen particle is emitted almost simultaneously, a fork is found in the photograph (Fig. 14 *D*) which resembles that for an ordinary collision, but whose distinguishing features give sufficient evidence of the union of the alpha particle with the nucleus of the heavier atom.

Thus one of the three tracks is about 10 times thinner than the other two, but appears as a continuous straight line in the photograph. Such a track is definitely characteristic of a hydrogen particle, since all heavier atoms give the broad tracks, and an electron gives a dotted track, commonly curved, unless it is much shorter.

In the only synthesis thus far found, a helium nucleus unites with the nucleus of an atom of nitrogen, to form one of fluorine, which at once dis-

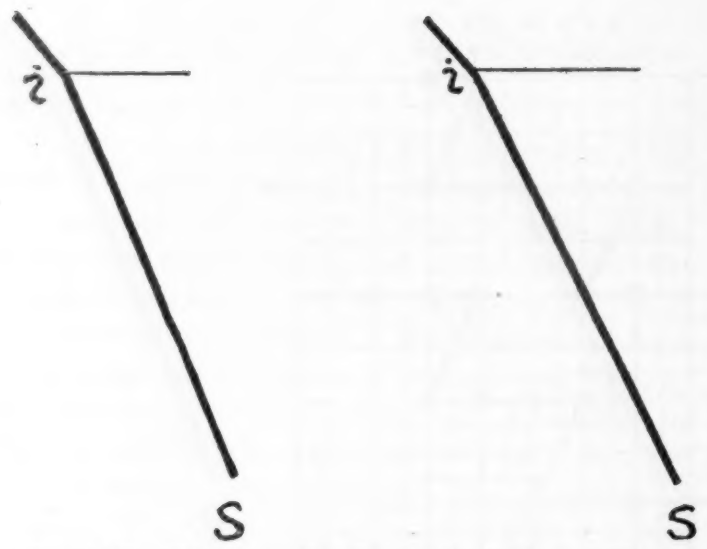

FIG. 14 D. Disintegrative-Synthesis of Atoms. Tracing taken from a photograph of two views at right angles of the tracks of atoms. The long heavy straight line in each view represents the track of a doubly charged helium atom, formed at (s) by the disintegration of an atom of thorium C′. The initial velocity of the helium atom is thirteen thousand miles per second. At the point (i) the helium atom, with a velocity of 11,600 miles per second, unites with a nitrogen atom in the air. A hydrogen atom (H^+) (faint track) is emitted at a velocity of 17,000 miles per second, and an oxygen atom (short heavy track) of mass 17 is found. This has an initial velocity of 3,300 miles per second.

integrates into hydrogen and oxygen of atomic mass 17.

If the faint track of the hydrogen nucleus shown in Fig. 14 *D* is too dim to be seen, a deflection such as that shown in Fig. 14 *C* is found.

Photographs of the natural disintegration of atoms of certain radioactive substances are much easier to obtain, and a tracing of one of these is shown in Fig. 15.

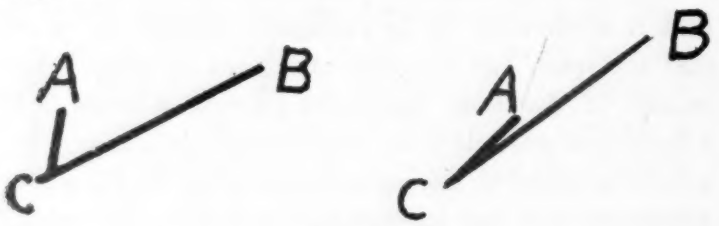

FIG. 15

FIG. 15. The Natural Disintegration of Atoms. Tracing taken from a photograph of two views, at right angles, of the tracks produced in air by the disintegration of radioactive atoms. An atom of one of the rare gases of the atmosphere (Thoron) disintegrates at C and shoots off a doubly charged helium atom (Track A). The atom left at C is an atom of bismuth. This disintegrates to give another helium atom (Track B), and an atom of lead. The track of the lead atom is shown by the very short stub at C. Since the mass of the atom of lead is 53 times larger than that of the helium atom, its velocity is 53 times smaller, so it has a much smaller range in air.

(10) *Fifth periodic relation.* It has been shown that if the atomic species are classified into four sets or classes (Table II) the number of possible species for each class is the same as for the others. However, the actual number of stable species is very high for Class I and decreases with the class number, until in Class IV only three species are known, and the abundance of these is very slight.

With the single exception of these three species a study of Fig. 8 (or Fig. 13) shows that along (horizontal) lines of even isotopic number every position which represents an element of even atomic number is filled (if in the general region of stability with reference to N/P), while every position of odd atomic number is vacant.

Thus from left to right the difference of composition of two adjacent known species is always that of a single alpha particle (α or p_4e_2).

The same difference is found for species of odd isotopic number, but here the positions which are filled correspond with odd atomic numbers. However, there is this important modification: in many regions every corner is filled, that is, the difference in composition from one species to the next is often that of a half-alpha particle of p_2e. In general a species of Class III lies in the plot either (*a*) between two species of Class II, or (*b*) adjacent along the horizontal line to a single species of Class II. At low atomic numbers condition (*a*), and at higher values condition (*b*) holds in general. It is possible that some species of low abundance may be found for which this rule does not hold, but there is a general apparent relation between the species of Classes II and III which is of great interest.

(11) *Are atom nuclei built up largely from alpha particles?* The data presented in this paper strongly suggest the idea, either that (1) The nuclei of atoms are formed largely by the aggregation of α-particles, or (2) the nuclei of atoms are largely composed of α-particles.

A few of the facts and relations which favor one or both of these ideas are recapitulated below.

(1) α-particles are given off in the disintegration of heavy atoms.

(2) α-particles are taken up in the synthesis of light atoms.

(3) Atoms whose nuclei have a composition which is the same as a whole number (j) of alpha particles (α_j) are by far the most abundant of all the types of atoms.

(4) They form also all the most abundant species.

(5) The elements of even number have been found on bombardment by fast α-particles to be more stable than those of odd number.

(6) The very light elements of even number exhibit a greater packing effect than those of even number.

(7) Fig. 13 gives very strong evidence for this point of view.

There is, however, evidence which seems to indicate that atom nuclei, even if they have been built up from α-particles, can not contain α-particles whose stability is not affected by their environment. Thus the packing effect or loss of energy in the formation of hydrogen from helium is large (0.77 per cent.). The additional packing effect in the formation of heavier atoms is not very great.

Therefore, the high stability of "non-radioactive" atom nuclei with reference to their disintegration into α-particles indicates that if the α-particle exists as a group inside the nucleus, it has nevertheless lost a part of its individuality.

The idea that the nucleus is built up by the aggregation of α-particles meets a certain difficulty with the nuclei of high charge, since it is difficult to see how the α-particles can obtain sufficient velocity to drive it through the region of mutual repulsion.

However, this difficulty is lessened by the fact that very few nuclei of high charge have been formed; that is, all elements of atomic number greater than 28 are extremely rare. Also the newer quantum mechanics cooperates in removing this difficulty, since it gives to the alpha particle, which has on the old basis too low a kinetic energy to pass through the repulsive region, a small chance of penetration.

On the whole, *there is very strong evidence that the α-particle plays a primary rôle in atom building.* Just what this rôle is it is difficult to say.

The question as to the existence of other proton-electron groups and their relation to atom building has been discussed in other papers, and need not be repeated here. If a half α-particle (p_2e) exists, the explanation of some of the relations would be simplified. However, since it is not found free in nature as an isotope of hydrogen, such half α-particles, if they exist at all, must have a great tendency to unite with other like particles to form a whole α-particles. Also, if neutrons (pe) or (pe_j) exist they would not be affected by a repulsive effect of the nucleus, since they have no net charge. If atoms grow heavier by the addition of neutrons, then only isotopes are formed, and atoms of higher atomic number can be formed only by the subsequent emission of beta-particles. Among other possible groups p_3e_2 is suggested, since this is the most common difference in composition between an atom of even atomic number and one of the next higher odd number.

(12) *Atom building and the composition of the earth.* A study of books on the composition of the earth exhibits the fact that the chemical and physical nature of the substances involved is looked upon as the primary factor in the determination of the composition. Or, if this is not the point of view, the general topic is entirely avoided.

A more fundamental point of view is that expressed in section (9): The composition of the earth is determined most largely by atomic stability and by the processes by which elements are built and disintegrate. The chemical and physical properties have, however, an important secondary effect. That oxygen is an extremely abundant element in the crust of the earth is not due in a primary sense, as was formerly supposed, to the low density of its compounds, but to the fact that its atoms are very stable, and probably to the ease with which it is formed.

(13) *The building of the earth.* The composition of the earth's crust has not been thought to exhibit evidence concerning the origin of the earth. Nevertheless, there seems to be a relation between the two.

The rarest (Fig. 16) of all classes of elements is known by the designation the rare gases. These gases are chemically and physically very much alike. However, there is no known relation between abundance and chemical or physical characteristics.

The abundance of the elements is related to the nuclear or non-chemical relations of the atomic species and elements as expressed by the new periodic system.

According to the second periodic relation, elements of even number, such as the rare gases, have a relatively high nuclear stability, and as a class should be abundant.

The obvious deduction is that the abundance of the rare gases on earth is much less than corresponds with the extent to which they were formed in the material from which the earth was built.

Thus, either: (1) In the process by which the earth was built the rare gases were not condensed, or (2) The rare gases have escaped from the earth since it has been formed.

Thus the gravitational energy of the mass or masses of material involved has at some time been insufficient to hold gaseous substances; that is, at some period the velocity of the molecules of the rare gases has exceeded what is termed the velocity of escape.

Only those elements which are held by chemical rather than physical forces are now present in the earth to any considerable extent.

Accurate determinations of the atomic weight of meteoric and terrestrial nickel (Baxter) and chlorine (Harkins and Stone) show that there is no appreciable difference between the atomic weights of the element in either case. This indicates either that the material of the earth's surface and of the meteorites has a common origin or else that the relative proportions of the isotopes in an element are determined

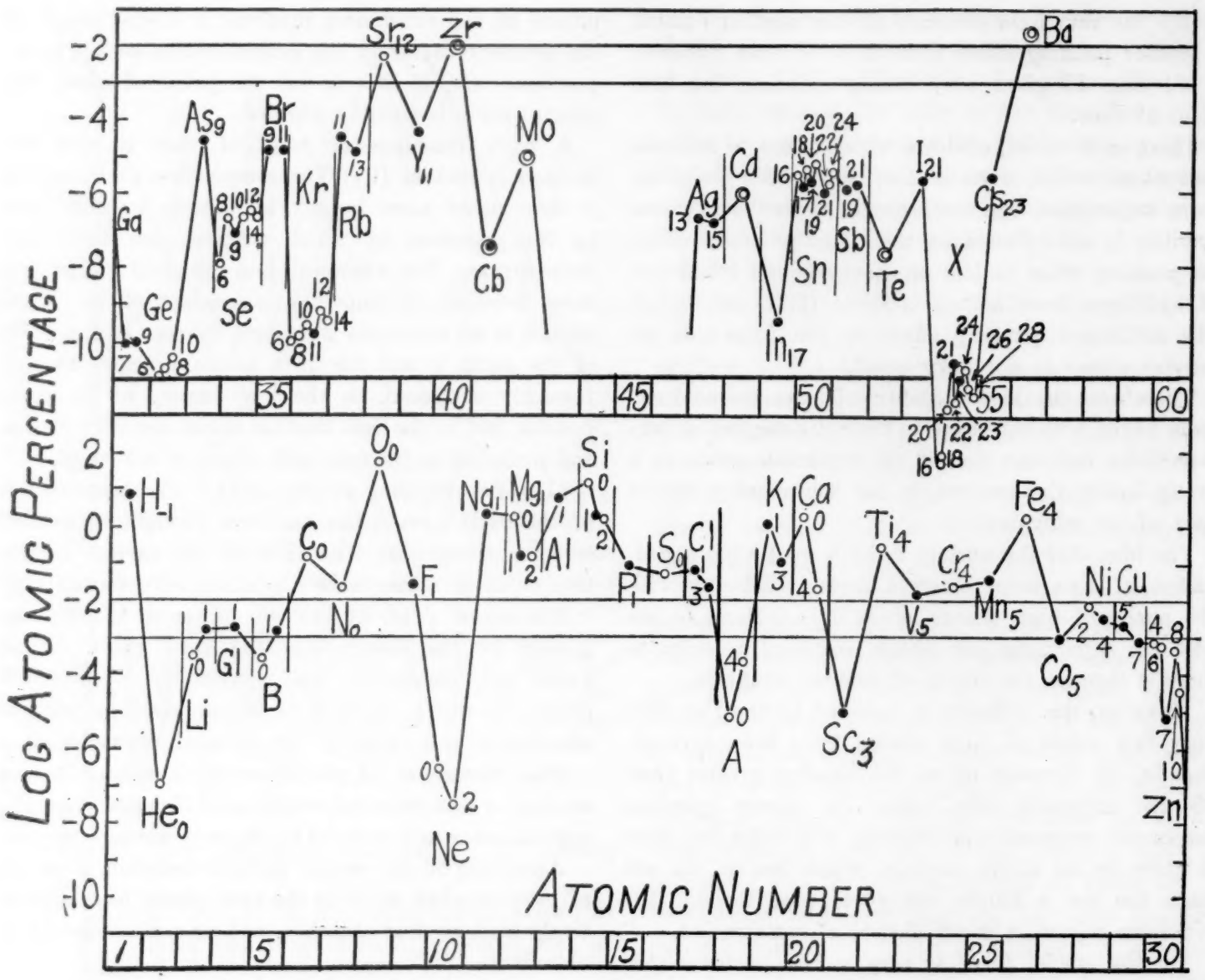

FIG. 16

by their relative stability and method of formation with reference to their source.

In addition this work seems to show that the natural processes which occur on earth and in the meteorites have not sufficed for their separation. This is not on the whole surprising, since the work of this laboratory indicates that the experimental separation of the isotopes of chlorine is a moderately slow process under favorable conditions, and thus far nickel has not been separated at all. Nevertheless, if the earth's surface is as old as it is commonly supposed to be, the above facts are somewhat remarkable. They agree with the idea obtained from other sources, that isotopes can not be separated by chemical means, and they indicate that conditions on earth and in the meteorites are not favorable for their separation by diffusion.

While these relations do not lead to any definite theory of the origin of the earth, they are entirely in accord with the planetesimal theory, which supposes that the earth at one time had a much smaller mass than at present, and that it has grown to its present size by the addition of small bodies such as meteorites or planetesimals. Whether or not they are in agreement with other theories depends upon the specifications of each of the theories. On the whole, it seems difficult to reconcile these facts with the theory that the earth has been formed by the condensation of a gaseous system of about the same mass as the earth of the present period.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE PRESENT ENROLMENT

THIS is the time of year when a report on the number of members enrolled in the American Association is most significant, for the association year closes on September 30, for which date the official count of members is made for the year. The following notes on the enrolment of September 30, 1929, will surely be of considerable interest to all readers of SCIENCE.

On any date the roll of the association consists of four categories: (*a*) endowment members (including sustaining members and life members), (*b*) paid-up annual members, (*c*) annual members in arrears for one year or less and (*d*) annual members in arrears for from one to two years. Names of annual members are retained on the roll till arrearage amounts to two years, but the journal subscription that goes with membership is not available. Annual dues are due October 1 and on that date all those enrolled whose arrearage amounts to two years are considered as having automatically resigned. There is therefore a difference between total paid-up membership and total enrolment. On September 30, 1929, enrolment in each of the four categories was as follows:

Endowment members	458
Paid-up annual members	17,062
Total paid-up membership	17,520
In arrears for one year	615
In arrears for two years	327
Total enrolment	18,462

Only 327 automatic resignations had to be recorded on October 1, 1929. In the year closing September 30 there had been 322 actual resignations and 187 deaths. On September 30 the total paid-up membership was 94.9 per cent. of the total enrolment. The number of new members and reinstatements for the year 1928–29 is 2,992, which is 16.2 per cent. of the total enrolment at the end of the year. For the same period the total loss in membership (including deaths, actual resignations and automatic resignations, the latter recorded October 1, 1928) is 858, which is only 4.6 per cent. of the total enrolment at the end of the year. The net gain in total enrolment for the year from September 30, 1928, to September 30, 1929, is 2,134.

Records of this sort have been kept since 1920, and it is interesting to compare the percentages given above with the corresponding values for preceding years. The value 94.9 is the highest yet recorded in its series, the next lower one being 94.5 per cent. for the year 1927–28. The same is true of the value 16.2, the next lower percentage in that series being 14.5, for 1923–24. The total loss in membership was 4.6 per cent. of the total enrolment at the end of the year for 1925–26 as well as for the year here considered, this value being the lowest in its series; the next higher value in that series is 4.9 per cent., for 1924–25. Data for paid-up membership and total enrolment for September 30 of each year from 1920 to 1928, inclusive, are shown and graphed in the new volume of Summarized Proceedings of the American Association, which was published October 15, 1929, and the same graphs are shown in the booklet on "The Organization and Work of the American Association." Copies of the booklet may be secured from the permanent secretary's office on request and the new volume of proceedings may be purchased from that office.

The recent rapid increase in the membership of the association reflects the correspondingly rapid growth of public interest in the advancement of science in America. There seems to be no reason to doubt that the association will continue to grow in a similar manner.

BURTON E. LIVINGSTON,
Permanent Secretary

OBITUARY

HORACE BUSHNELL PATTON

HORACE BUSHNELL PATTON, PH.D., professor emeritus of the Colorado School of Mines, died at Atascadero on July 15, 1929, after an illness resulting from an operation for appendicitis. He was born in 1857, graduated from Amherst in 1881 and after a couple of years at Howard University, of which his father, Rev. W. W. Patton, was for many years president, he went to Europe. He studied geology (and especially petrography) first at Leipzig under Zirkel, then at Heidelberg in Rosenbusch's laboratory, where I first met him and had the pleasure of field excursions with him, not always geological, I remember. He took his degree *summa cum laude* in 1887 and remained as Rosenbusch's assistant for a short time. A short paper[1] in German on the minerals of a diorite crystallizing out into a miarolitic cavity which might well be called to the attention of certain recent writers and his thesis[2] on the origin of the Marienbad serpentine from a peridotite, not then a hackneyed subject, were the fruit of his German stay. Returning to America in 1888, after brief teaching appointments at Howard University and Rutgers, 1889, he was again associated with Dr. L. L. Hubbard and myself in more congenial work, combining research and teaching for the Michigan Geological Survey and Mining School at Houghton. His research here was largely petrographic and was to have been correlated with work by Dr. Wadsworth, which the latter's resignation as state geologist upset. However, there are a few pages signed by him in Wadsworth's 1892–93 report. Dr. Patton then accepted a call to the Colorado

[1] "Hornblende, Oligoklas und Titanit aus Drusenraumen im Schriesheimer Diorit" (Separat-Abdruck aus dem Neuen Jahrbuch fur Mineralogie, etc. 1887. Bd. 1)

[2] "Die Serpentin- und Amphibolgesteine nordlich von Marienbad in Bohmen." Wien 1887. Alfred Holder, K. K. Hof- und Universitäts-Buchhandler.

School of Mines and remained there nearly a quarter century, from 1893 to 1917. For a time he was acting president. While there he prepared a number of papers for the Colorado Scientific Society and Geological Survey on minerals such as topaz, opal, tourmaline and the zeolites of Table Mountain and a number of mining districts.[3]

Perhaps the most widely interesting of his papers, however, are those before the Geological Society of America, one showing that the "rock streams" previously supposed to be glacial were not such but a result of slow creep, and the working up of Crater Lake with Diller. After he ceased to teach, he continued in geological private practice, at first for the Union Pacific.

Of a family prominent in affairs of the church, as his very name shows Christian and not narrow, he was true to the family tradition. Wherever he went he helped in the church, not only with his fine bass voice in the choir, but financially as well. I remember the internal chuckle I gave when we were in Houghton and a pastor was congratulating himself to me on the handsome increase in the foreign missionary collection of his church. I knew that the increase was due solely to Patton, who had recently arrived, but I did not disturb his complacency. Patton's religious attitude was not merely of voice and pocketbook. It represented inward conviction as came out in conversations when tramping as German fellow students. Those were the happy days of Henry Drummond and Charles Kingsley, when we had not heard of fundamentalism and saw no difficulty in being both evolutionist and evangelical.

ALFRED C. LANE

TUFTS COLLEGE

MEMORIALS

THE Illinois State Board of Natural Resources and Conservation has passed the following minute and directed that a copy be forwarded to Professor Rollin T. Chamberlin:

For thirteen years, during the period when the present Geological Survey of Illinois was being organized and its policies in process of formulation, the late Professor Thomas Chrowder Chamberlin served as its geologic adviser. At the height of a distinguished career crowded with many and varied duties, he gave generously of his time and rich experience to the inauguration of the survey's work along broad, sane and useful lines. This board desires to record herewith its appreciation of the splendid quality of the public services so given and its gratitude for many years of association with one who is universally recognized as the leader in his field in America.

The following resolution regarding the late Dr. William H. Carmalt was voted at a recent meeting of the Directors of the New Haven General Hospital Society:

Voted, to record the sorrow of the Directors of the General Hospital Society of Connecticut at the death of William Henry Carmalt, M.D., M.A., LL.D., for five years (1918–1923) president of the society; for over fifty years (1876–1929) actively interested in promoting the welfare of the society and of the school of medicine, Yale University, where he taught from 1876 to 1907. Distinguished exponent of his profession, he was an original member of the American Ophthalmological Society, a member of the Congress of American Physicians and Surgeons, and an honorary Fellow of the American College of Surgeons. His ability and distinction were fittingly recognized alike through his election by his colleagues as president of the Connecticut State Medical Society and of the American Surgical Association, and by the honorary degrees conferred upon him by Yale University. Beloved in the community of New Haven, he was equally loved and honored in the commonwealth of Connecticut, and far beyond its borders in distant states and cities where his former students carried with them a feeling of deep affection for him as a man, a high regard for him as a teacher and practitioner. Not in words can the Directors of the General Hospital Society of Connecticut adequately express their esteem for him nor their sense of loss at his death.

RECENT DEATHS

THE death in Paris is announced of Dr. Harry Taylor Marshall, since 1908 Walter Reed professor of pathology and bacteriology in the University of Virginia, at the age of fifty-four years.

DR. EDWARD N. LIBBY, professor of the theory and practice of medicine, dean of Tufts College Medical School, died on November 5 at the age of sixty-one years.

WILLIAM R. HART, formerly a member of the faculty of the Massachusetts Agricultural College and the first to organize a department for training teachers of agriculture, has died at the age of seventy-six years.

R. WILFRED BALCOM, chemist in charge of food control of the Food, Drug and Insecticide Administration of the U. S. Department of Agriculture, died suddenly on October 17.

DR. THOMAS BARLOW WOOD, Drapers professor of

[3] "Tourmaline and Tourmaline Schists from Belcher Hill, Colo.," Bulletin, Geol. Soc. of Am., vol. 10, pp. 21–26; "Thomasonite, Mesolite, and Chabazite from Golden, Colo.," Bulletin, Geol. Soc. of Am., vol. 11, pp. 461–474; "Concretions of Chalcedony and Opal in Obsidian and Rhyolite in Colo.; Some Minerals Recently Received by the Colorado School of Mines," Quarterly of the Colorado School of Mines, Oct., 1907; "Topaz-Bearing Rhyolite of the Thomas Range, Utah," Bulletin, Geol. Soc. of Am., vol. 19, pp. 177–192; "Rock Streams of Veta Peak, Colorado," Bulletin, Geol. Soc. of Am., vol. 21, pp. 663–676; "The Montezuma Mining District of Summit County, Colorado; The Grayback Mining District," Colorado State Geological Survey, Bulletin 24.

agriculture of the University of Cambridge, died on November 6 at the age of sixty years.

DR. KARL VON DEN STEINEN, director of the Berlin Ethnological Museum and professor of ethnology in the university, died on November 6 at the age of seventy-four years.

A CORRESPONDENT writes: "Dr. Edwin Le Fevre, assistant bacteriologist in the food research division of the U. S. Department of Agriculture, died suddenly while at his work on October 25. Dr. Le Fevre entered the government service in 1909 in the old Bureau of Chemistry, carrying out bacteriological investigations pertaining to the enforcement of the federal food and drug law. He specialized in the field of fermentations and won for himself a wide reputation as an authority on the manufacture of pickles and sauerkraut. Dr. Le Fevre was sixty-nine years of age, and at the time of his death was actively engaged in research work on the deterioration and preservation of food products. Many of his studies have been reported in the form of government bulletins which have enjoyed a wide distribution, and it is with deep regret and sincere appreciation that his coworkers take up the work where he left off."

SCIENTIFIC EVENTS

ACTIVITIES OF THE ROCKEFELLER FOUNDATION

THE report of the Rockefeller Foundation for 1928 shows that a total of $21,690,738 was expended during the year. The principal outlays, as enumerated by President George E. Vincent, were as follows:

Contributed to the development of medical sciences through provision of funds for land, buildings, operation or endowment for eighteen medical schools in fourteen countries.

Provided for the support of Peking Union Medical College.

Made minor appropriations for improving pre-medical instruction in China and Siam, for operating expenses of seventeen hospitals in China, and for laboratory supplies, equipment and literature for European medical centers which are still feeling the after-effects of the war.

Through small grants assisted certain departments of medical schools in France, Italy and Ireland which offer exceptional facilities for graduate study.

Continued to contribute toward the advancement of the biological sciences in institutions in four countries.

Assisted the development of professional public health training in eight schools and institutes in seven countries and in twelve field training stations in the United States and abroad.

Gave aid to fifteen nurse training schools in ten countries.

Helped Brazil to combat a new outbreak of yellow fever.

Continued studies of yellow fever on the west coast of Africa.

Took part in malaria control demonstrations or surveys in six of the American states and in eighteen foreign countries.

Continued contributions toward the emergency budgets of eighty-five county health organizations in seven states of the Mississippi flood area.

Aided the governments of twenty-one countries in fighting hook-worm disease.

Gave funds to organized rural health services in 191 counties in the United States and toward state supervision of such services in fourteen states, as well as assisting in local health work in twenty-three foreign countries.

Aided in the establishment or maintenance of certain essential divisions in the national health services of twenty-three foreign countries and in the state health departments of nineteen American states.

Provided, directly or indirectly, fellowships for 802 men and women from forty-six different countries, paid the traveling expenses of sixty-one officials or professors making study visits in the United States or abroad and provided similar opportunities for 127 nurses and other public health workers.

Contributed to the work of the health organization of the League of Nations through the support of international interchanges of public health personnel and the development of a world-wide service of epidemiological intelligence and public health statistics.

Lent staff members as consultants to many foreign governments.

Made surveys of health conditions or of medical and nursing education in five countries.

Collaborated with the Rockefeller Institute for Medical Research in field studies of respiratory diseases and verruga peruana.

Assisted in mental hygiene projects in the United States and Canada, in demonstrations in dispensary development, research and teaching in hospitals and clinics in New York City, and in numerous other undertakings in public health, medical education and allied fields.

LECTURES BEFORE THE MAYO FOUNDATION

THE last of the series of lectures on physiology and physiologic chemistry by eminent European professors of these subjects was presented at the Mayo Foundation on October 8. The series has included the following:

July 18.—E. Waldschmidt-Leitz, German Technical School, Prague, "The structure of proteins in the light of enzymatical research."

July 25.—Torsten L. Thunberg, professor of physiology, University of Lund, "Dehydrogenases and their uses in biochemical analyses."

July 29.—E. Lequeur, professor of physiology, University of Amsterdam, "Sex hormones."

Aug. 1.—G. v. Anrep, lecturer in physiology, University of Cambridge, "Conditioned reflexes."

Aug. 8.—M. v. Frey, professor of physiology, University of Würzburg, "Physiology of the special senses."

Sept. 9.—Bernhard Fischer, professor of pathology, University of Frankfurt a. M., "Gas treatment of malignant tumors."

Sept. 13.—Kurt Felix, Second Medical Clinic, Munich, "The oxidation of uric acid in the animal body."

Sept. 16.—Joseph Barcroft, professor of physiology, University of Cambridge, "Hemoglobin."

Sept. 17.—Joseph Barcroft, "The spleen and the circulation."

Sept. 26.—Z. A. Orbeli, professor of physiology, Medical Institute, Leningrad, "Studies on the function of the sympathetic system."

Sept. 27.—George V. Volborth, professor of physiology, State University of Kharkov, Ukraine, "Conditioned reflexes."

Oct. 1.—Friedrich Verzar, professor of physiology, University of Debreczen, "The hormonic regulation of the number of red blood corpuscles."

Oct. 3.—Leon Asher, director of physiological institute, Berne, "New facts on the physiology of the thyroid gland."

Oct. 4.—Leon Asher, "The action of specific diuretics and the secretion of urine under physiological conditions."

Oct. 7 and 8.—Karl Thomas, director of the physiological institute, Leipzig, "Metabolism of food and tissue protein."

SYMPOSIUM ON AIRCRAFT MATERIALS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS

AT the annual meeting of the American Society for Testing Materials, which will be held at Atlantic City from June 23 to 27, 1930, a symposium on aircraft materials is planned, to which will be devoted two sessions. The committee on papers and publications has secured the cooperation of an advisory committee which will assume responsibility for securing the papers and authors. This committee, under the chairmanship of Mr. H. C. Knerr, consists of the following:

H. C. Knerr, chairman, consulting metallurgical engineer, Philadelphia, Pa.

E. P. Warner, editor, *Aviation*, McGraw-Hill Publishing Company, Inc.

National Advisory Committee for Aeronautics: Dr. G. W. Lewis, Washington, D. C.

Bureau of Aeronautics, U. S. Navy Department: Commander R. D. Weyerbacher, manager, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pa.

Army Air Service: J. B. Johnson, chief, material section, Air Corps, Wright Field, Dayton, Ohio.

U. S. Department of Commerce: Major Clarence E. Young, chief, aeronautics branch, U. S. Department of Commerce, Washington, D. C.

U. S. Bureau of Standards: H. L. Whittemore, chief, engineering mechanics section, VI-5; Dr. H. S. Rawdon, senior metallurgist.

Guggenheim Foundation: Dr. Alexander Klemin, consulting engineer, School of Aeronautics, New York University.

Massachusetts Institute of Technology: Dr. J. S. Newell.

Aircraft and Engine Manufacture: Harold Backus, materials engineer, Berliner-Joyce Co., Baltimore, Maryland; Captain H. C. Richardson, director of engineering, Great Lakes Aircraft Corporation, Cleveland, Ohio; T. P. Wright, chief engineer, Curtiss Aeroplane and Motor Corporation, Garden City, L. I., New York; R. R. Moore, metallurgist, Wright Aeronautical Corporation, Paterson, New Jersey.

Materials Manufacture: Dr. R. S. Archer, director of research, Aluminum Company of America, Cleveland, Ohio; Dr. J. A. Mathews, vice-president and metallurgist, Crucible Steel Company of America, New York City.

It is expected that perhaps twelve to fifteen papers will be secured, each definitely limited in size so as to constitute essentially a résumé and summary of existing knowledge on the subject covered. The symposium will be confined to the consideration of materials entering into the engines and structure. It is expected that much information of value to the aircraft industry will be developed.

ASTRONOMERS CARRYING ON RESEARCHES AT THE HARVARD OBSERVATORY

FOUR astronomers have recently arrived at the Harvard Observatory for longer or shorter stays to carry on researches. In making this announcement the observatory made public a list of five visitors who have recently left after pursuing researches with the aid of the observatory staff.

Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B. C., has arrived to spend two or three weeks. He is a special student of the rotation of the galaxy, and has in his charge the second largest telescope in the world—the property of the government of Canada. Dr. Plaskett is the father of Professor H. H. Plaskett, of the Harvard Observatory.

Professor Svein Rosseland has been called as lecturer in cosmic physics for one year. He is director of the University Observatory at Oslo, Norway, and is one of the leading men of Europe in theoretical astrophysics. He is lecturing in astronomy 11, a theoretical course in cosmic physics.

Mr. Bart J. Bok, of the Kapteyn Astronomical Laboratory in Groningen, Holland, has joined the observatory staff for one year to carry out researches in spectrophotometry and stellar statistics.

Dr. Leon Hufnagel, of Poland, has returned to the observatory for a few months to continue his astrophysical researches.

Dr. A. Pannekoek, director of the astronomical institute of the University of Amsterdam, visited the observatory for a few days in October in the interest of his researches on the structure of the Milky Way. One telescope is used continually on good nights in making photographs of the northern Milky Way for Dr. Pannekoek's researches. He also consulted with Miss Cannon on the work of the Henry Draper Extension—the classification by her of faint stars in the Milky Way—a research in which he is especially interested.

Professor E. A. Milne, of the University of Oxford, spent several weeks at the observatory, delivering two lectures, holding many conferences with the staff on subjects of theoretical astrophysics. Many of Dr. Milne's theoretical researches are tested by Dr. Payne and her associates at the Harvard Observatory, using the spectrograms made in South America and at Cambridge.

Dr. Albrecht Unsold, of the University of Munich, spent some weeks at the observatory, joining in the special conferences (with Milne, Plaskett, Payne, Dunham and others) on line contours and in photometric studies, using Harvard photographs, of the structure and distance of the Coal Sack in the southern Milky Way.

Dr. Theodore Dunham, Harvard '21, of the Mount Wilson Observatory, spent two weeks taking part in the conferences on line contours and the structure of stellar atmospheres.

Professor Boris Gerasimovic has returned to Kharkov, Russia, after spending nearly three years at the observatory as research associate.

THE SCIENTIFIC BOOK CLUB

A SCIENTIFIC Book Club has been formed that will furnish to its members each month a new scientific book selected by an editorial committee, of which Dr. Kirtley F. Mather, head of the department of geology at Harvard University, is chairman. Other members of the committee are:

Dr. Arthur H. Compton, professor of physics at the University of Chicago.
Dr. Edwin G. Conklin, professor of biology at Princeton.
Dr. Harlan T. Stetson, director of the Perkins Observatory at Ohio Wesleyan University.
Dr. Edward L. Thorndike, professor of educational psychology at Teachers College, Columbia University.

An advisory committee has been appointed with the following members:

Dr. Isaiah Bowman, director of the American Geographical Society.
Dr. Rollo W. Brown, author and literary critic.
Dr. Aleš Hrdlička, curator, division of physical anthropology, Smithsonian Institution.
Dr. J. McKeen Cattell, editor of SCIENCE.
Dr. Vernon Kellogg, permanent secretary of the National Research Council.
Dr. Burton E. Livingston, permanent secretary of the American Association for the Advancement of Science and director of the laboratory of plant physiology of the Johns Hopkins University.
Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics and chairman, executive council, California Institute of Technology.
Dr. Michael I. Pupin, professor of electromechanics, Columbia University.
Dr. Forest R. Moulton, consulting engineer.
Dr. Harlow Shapley, director of the Harvard Observatory.

Dr. Mather in discussing the significance of the project said in part:

> The launching of the Scientific Book Club is an indication of the interest in science that is rapidly developing in America. I am fully convinced that there are thousands of intelligent men and women who are eagerly searching for reliable and truthful information concerning the great contributions to knowledge which have resulted from the widening spread and deepening hold of scientific habits of mind, both in this country and abroad. These individuals are continually on the lookout for opportunities to keep in touch with the current achievements in the realm of science.
>
> Now, as never before, men and women must look to science in the building of a better world and the improvement of human affairs. Consequently, there must be adequate machinery for accelerating the spread of scientific information throughout the civilized world.
>
> The average layman can select for himself those books of fiction and biography which appeal most to his taste, but few are qualified to pass upon the scientific value and technical accuracy of scientific books. Only men of science are in a position to offer guidance in this direction.

Each month a book-review magazine will be sent to every member of the Scientific Book Club. This magazine will contain a full review of the designated book of the month as well as descriptive summaries of other volumes recommended by the committee. Members may choose the selected book or have the option of substituting any volume on the supplementary list.

The editorial office of the Scientific Book Club is at 22 Oxford Street, Cambridge, Massachusetts, and the business office at 80 Lafayette Street, New York City.

SCIENTIFIC NOTES AND NEWS

THE honorary doctorate of the University of Paris was conferred on Professor Albert Einstein on November 9.

THE Federation of Women's Clubs of New York City conferred its medal of honor on Mme. Curie prior to her return to Paris.

THE Davy medal of the Royal Society has been awarded to Dr. Gilbert N. Lewis, of the University of California, for his work on thermodynamics and the theory of valence; the Copley medal to Professor Max Planck, of the University of Berlin, for his contributions to theoretical physics and especially as originator of the quantum theory; the Hughes medal to Professor Hans Geiger, of the University of Kiel, for his invention and development of methods of counting alpha and beta particles. Royal medals have been awarded to Professor J. E. Littlewood, of Cambridge, for his work on mathematical analysis and the theory of prime numbers, and to Professor Robert Muir, of the Medical Research Council, for contributions to technical immunology.

THE Academy of Sciences of Amsterdam has conferred the Roozeboom gold medal on Dr. J. J. Van Laar, formerly professor in the University of Amsterdam. This medal is awarded every ten years for the work that has contributed most to the advancement of physical chemistry. Dr. Van Laar has for nearly twenty years lived and worked in Switzerland.

HONORARY life membership of the American Institute of Mining and Metallurgical Engineers was conferred on Baron Takuma Dan at a meeting held in Tokio on November 3. F. W. Bradley, president of the institute, presided, and Professor Robert H. Richards, emeritus professor at the Massachusetts Institute of Technology, under whom Baron Dan studied, sponsored the presentation.

THE Boston Society of Natural History has elected to honorary membership Gustaf Adolph Frederik Molengraaff, of Delft, Holland, in geology; Professor Angel Cabrera, Buenos Aires, in mammalogy, and Professor George Henry Falkiner Nuttall, of the University of Cambridge, in zoology.

THE Grasselli medal of the Society of Chemical Industry was presented to Bradley Stoughton, professor of metallurgy at Lehigh University, in recognition of his work on alloys at a joint meeting on November 8 of the American Chemical Society, the Société de Chimie Industrielle and the American Electrochemical Society. Dr. B. D. Saklatwalla, of the Vanadium Corporation of America, presented the medal and spoke on the work accomplished by Professor Stoughton. Professor Stoughton spoke on "Metals Used in Airplane Construction."

A CORRESPONDENT writes: "Mr. H. D. Chope, who is connected with the department of epidemiology and public health of the Stanford University Medical School, San Francisco, has been infected with the fungus, *Coccidiodes immitis*, causing the rare and severe disease of the lungs known as coccidiodal granuloma. The infection occurred during experimental investigations on which Mr. Chope was working. He is anxiously hoping to return to his laboratory to continue his investigations of this disease."

DEAN DEXTER S. KIMBALL, of the college of engineering of Cornell University, has been appointed acting president of Cornell University during the leave of absence of Dr. Livingston Farrand, who is spending November and December in Italy.

DR. VERNON KELLOGG, permanent secretary of the National Research Council, has been elected acting director of Science Service pending consideration of the appointment of a successor to the late Dr. E. E. Slosson.

DR. E. D. MERRILL, dean of the college of agriculture of the University of California, will take up his work as director of the New York Botanical Garden on January 1.

C. H. BIRDSEYE has resigned as chief topographic engineer of the U. S. Geological Survey and has been succeeded by J. G. Staack.

GLENN S. SMITH has resigned as division engineer of the Atlantic division of the topographic branch of the U. S. Geological Survey, and Albert Pike has been appointed to this position. Mr. Smith will continue part-time service in the survey.

ASSISTANT PROFESSOR E. E. LIBMAN, of the University of Illinois, has resigned to accept a position in the marine and aircraft engineering department of the General Electric Company.

W. P. THOMPSON, professor of biology at the University of Saskatchewan, has been granted leave of absence for twelve months and is taking a special course of study in the department of genetics of the University of California. J. R. Fryer, who has been taking graduate work at the University of California for the past year, has resumed his work as associate professor of genetics and plant breeding at the University of Alberta, Edmonton.

Dr. Bernard Hague, principal lecturer in electrical engineering at the University of Glasgow, Scotland, is serving as visiting professor of electrical engineering at the Polytechnic Institute of Brooklyn.

IT is reported in *Popular Astronomy* that the staff of the observatory of the University of Michigan has during the past summer had associated with it in study, instruction and research a number of astronomers from other institutions. Those who spent some time at Ann Arbor were: Dr. Theodore Dunham, of Mt. Wilson Observatory; Mr. C. T. Elvey, of the Yerkes Observatory; Dr. Alice H. Farnsworth, of Mount Holyoke College; Professor H. S. Harp, of Wittenberg College; Dr. Alberta M. Hawes, of Vassar College; Mr. Roy Marshall, of Ohio Wesleyan University; Dr. E. A. Milne, of the University of Oxford; Mr. N. L. Pierce, of Doane College; Dr. H. H. Plaskett, of Harvard College Observatory; Mr. R. M. Petrie, of the University of British Columbia, and Mr. W. J. Williams, of Baylor University.

THE Guggenheim Fund for the Promotion of Aeronautics, Inc., as reported in SCIENCE recently, made a grant of $30,000 to Syracuse University to establish a course in aerial photo-surveying and mapping in the college of applied science. Five experts have accepted the invitation of the chancellor to act as an advisory board in connection with the planning of the new course. The members of this committee are: Carl S. Bausch, manager of the Bausch and Lomb Optical Company, Rochester, New York; J. B. Beadle, of the Brock and Weymouth Company, Philadelphia, Pennsylvania; Colonel Claude H. Birdseye, Washington, D. C.; Sherman M. Fairchild, president of the Fairchild Camera Company of New York, and Captain E. S. Land, vice-president and treasurer of the Guggenheim Fund, New York.

THE Fannie Frank Leffmann Memorial Lecture of the Wagner Free Institute of Science was given recently by Dr. Howard McClenahan, secretary of the Franklin Institute. The lecture, entitled "A Great Scientific Museum for Philadelphia," was illustrated with motion pictures.

DR. R. G. AITKEN, associate director of the Lick Observatory, delivered an address entitled "A Total Eclipse of the Sun" before the East Bay Astronomical Association at the Chabot Observatory on October 5.

PROFESSOR ALEXANDER SILVERMAN, head of the department of chemistry of the University of Pittsburgh, delivered an address at the Bankers Industrial Exposition, New York City, October 31, on "Glass: an Indispensable Commodity."

DR. IRVING LANGMUIR, associate director of the research laboratory of the General Electric Company and president of the American Chemical Society, was the guest of honor at a luncheon given by the New York and New Jersey sections of the American Chemical Society and the Chemists' Club on October 19. After the luncheon Dr. Langmuir made an address on "Chemical Reactions Produced by Heating Tungsten or Platinum Filaments in Gases."

THE sixth session of the International Congress of Mines and Metallurgy will be held in Liége in June, 1930.

A THREE-DAY session of the Association of American Medical Colleges opened at the Medical Center of Columbia University on November 7. During the meeting President A. Lawrence Lowell spoke at a joint session with the Association of American Universities on "Resident Colleges at Harvard University." Dinner addresses were made by President Nicholas Murray Butler, of Columbia University, and Dr. Burton D. Myers, president of the association. Among speakers at the other sessions were Dr. Guy Stanford Ford, dean of the graduate school of the University of Minnesota, and Dr. J. C. Metcalf, dean of the graduate schools of the University of Virginia.

A LUNCHEON was given by the British government in connection with next year's World Poultry Congress at the Crystal Palace on October 28 to representatives of the European section of the World Poultry Science Association and the general committee of the congress. Dr. Addison, parliamentary secretary to the Ministry of Agriculture, who presided, declared that the government would spare no effort to make the congress a success. Forty-five countries had already agreed to participate, and thirty had elected national committees to insure effective representation.

THE corner-stone for the new Chicago Lying-in-Hospital, to be built at the cost of $1,800,000 on the campus of the University of Chicago, was laid on November 5. The hospital will have 150 beds and will be completed by January, 1931. Coincident with the laying of the corner-stone the University of Chicago announced the creation of a new department of obstetrics and gynecology, with Dr. Joseph B. De Lee as chairman. Dr. Fred Lyman Adair, professor in the University of Minnesota and chief of the obstetrical division of the Minneapolis General Hospital, has been called to the new department. Dr. De Lee founded the Chicago Lying-in-Hospital and Dispensary in 1895 and has been its medical director since.

A PETITION for a chapter of Sigma Pi Sigma, honorary physics fraternity, has been granted to a group at the University of Oklahoma, and a chapter will be installed there in the near future. The expansion program of the society includes the installation of several other chapters during the present academic year. At present there are ten chapters.

UNIVERSITY AND EDUCATIONAL NOTES

GIFTS to Columbia University include $200,000 from Mrs. Charlotte E. De Sers, for the endowment of a professorship in memory of her father, Robert Johnson Niven, formerly a student of Columbia. The sum of $100,000 has been bequeathed by the late Charles H. Ditson to the department of music and by Frederick Bertuch to establish a fund for needy students; Colonel William Boyd Thompson, of Yonkers, formerly a student of the school of mines, has given $100,000 to the school of engineering. $70,000 from the Rockefeller Foundation has been received for research.

WORK will soon start on Ryder Hall, the new electrical engineering laboratory of Union College. The building is the gift of H. Russell Ryder, of New York, and will cost about $150,000. It will be completed next spring. Mr. Ryder has also provided for maintenance.

THE trustees of Pennsylvania State College have renamed the School of Mines and Metallurgy as the School of Mineral Industries. Expansion of all divisions of the School of Mineral Industries is expected with the completion next year of a new building for the school.

DR. GEORGE A. WORKS was formally inaugurated as president of the Connecticut Agricultural College on November 8. Governor John H. Trumbull extended the greetings of the state to the new president, and addresses were made by Chancellor Samuel P. Capen, of the University of Buffalo, and by President James L. McConaughy, of Wesleyan University.

THE *Experiment Station Record* reports that George S. Templeton, head of the animal husbandry department of the Mississippi Agricultural College and Station for the past six years, recently resigned to accept a position with the educational bureau of the National Cottonseed Crushers Association. D. S. Buchanan, professor of animal husbandry and associate animal husbandman, has been appointed head of the department, and the resulting vacancy filled by the appointment of R. H. Means.

DISCUSSION

THE OCCURRENCE OF ROTENONE IN THE PERUVIAN FISH POISON "CUBE"

A METHOD of fishing employed by natives of tropical countries is unique and effective. They throw pounded poisonous plants into streams or pools to stupefy the fish. This causes them to rise to the surface of the water, whereupon they are speared or netted.

Some of these fish poisons, notably certain species of Derris, have been shown to be good insecticides and therefore have attracted the attention of entomologists and others interested in insect control. However, little botanical information is available concerning many of these plants, which are known by native names only.

Derris has been the member of this group of poisons most extensively investigated, and rotenone has been shown to be the active principle of two species, namely, *Derris chinensis* and *Derris elliptica*. Rotenone has also been isolated from plants other than Derris, namely, *Lonchocarpus*,[1] *Milletia taiwaniana*, Hayata,[2] *Mundulea suberosa*, Benth,[3] and *Ormocarpum*.[3]

Among the poisonous plants that have recently attracted attention as insecticides is the Peruvian fish poison "cube." It is the root of a plant whose botanical classification is uncertain, but it is thought to be *Tephrosia piscatoria*. "Cube" is an active insecticide, and a patent has been granted covering its use for this purpose.[4]

Two samples of this material were examined, and in each case rotenone was found to be the active principle. In both cases rotenone was obtained by the usual procedure of ether extraction, after which it was purified by recrystallization from alcohol. The first sample of "cube" gave 7.2 per cent. of crude rotenone with a melting-point of 158°; upon recrystallization the melting-point rose to 163°, and when mixed with an authentic sample of rotenone there was no depression. George L. Keenan, of the Food, Drug and Insecticide Administration of the Department of Agriculture, found its optical properties to be as follows: In ordinary light the material consists of thin, irregular six-sided plates. The indices of refraction are $n_\alpha = 1.610$; $n_\gamma = 1.665$; both ± 0.003. The birefringence is very strong and the polarization colors brilliant. These data are identical with those obtained with an authentic analytically pure sample of rotenone.

The second sample of "cube" gave 7.1 per cent. of crude rotenone with a melting-point of 159°. Upon recrystallization it was identical with pure rotenone as to melting-point, mixed melting-point and optical properties.

From the information obtained with these two samples it would seem that "cube" would serve as an

[1] Greshoff, *Ber. d. d. Pharm. Ges.*, 9: 215 (1899); Tattersfield, Gimingham and Morris, *Ann. Appl. Biol.*, 1926, p. 424.

[2] Atsumi and Shinada, *Yearbook of Pharmacy*, 1924, p. 209.

[3] Greshoff, *loc. cit.*

[4] U. S. Patent 1,621,240.

excellent source of rotenone, provided the plant can be obtained in quantity.

E. P. CLARK

U. S. DEPARTMENT OF AGRICULTURE

ON THE PROPERTIES OF THE ELECTRON

SOME of the main difficulties of the Bohr atom disappear, the writer has shown,[1] if the electron possesses the property that it absorbs radiant energy during its motion, which induces a decrease of its electrical field and under certain conditions ejects again the energy as radiation. A deduction of these properties was given based on thermodynamics and kinetic theory, which will be further elaborated in subsequent papers. The results may also be obtained in other ways, one of which will be pointed out here.

Suppose that an electron gas kept at constant temperature is subjected to a powerful magnetic field. The path of each electron will now possess greater curvature than before, resulting in an increased transformation of its kinetic energy into radiant energy, due to the acceleration it undergoes. A limiting case is that the concentration of the electrons is so small that in most cases they pass clear across the chamber. Thus the kinetic energy of the electrons will continually decrease. But this is manifestly an absurd result. Hence each electron will on the average recover its velocity during collision. This can take place only at the expense of the surrounding radiant energy, since the kinetic energy lost took this form. If radiation has the orthodox form, namely, that it consists of continuous electromagnetic waves, the electron can recoup the lost energy only by the gradual absorption of radiant energy which is stored up as internal energy. Since the emission of radiation due to the acceleration of the electron depends on the curvature of its path, the rate of absorption of radiant energy will similarly be dependent. The increase in velocity during a collision of the electron can be caused only by an increase in its field during the process, its internal energy supplying the necessary energy. Hence its field decreased during its mean free path. These are the results obtained before.

R. D. KLEEMAN

SCHENECTADY, NEW YORK

MANAYUNKIA SPECIOSA (LEIDY) IN THE DULUTH HARBOR

IN the course of a biological investigation of the Duluth Harbor, specimens of *Manayunkia speciosa* (Leidy) were taken in the dredge samples. Dr. Leidy described this annelid in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, 1883. There are some additions to be made and some differences in the description that will place this form in its proper place in an analytical table or key.

In general the worm answers to his description. The mature specimens measure about 2.9 mm, although individuals in the act of fission may reach 4.9 mm. These latter were the ones that Dr. Leidy made his description from, although he did not actually see them divide. The worm is somewhat transparent with some pigment around the branchial lobes, and the general shape is as he described it, except the seventh segment, which is no different from the rest except that it is about twice as long as the preceding segments. It is at this point that the worm divides, and, as Dr. Leidy rightly guessed, the expanded forepart of this segment is the beginning of a head for the new individual.

It has the characteristic tentacles and ciliated branchiae of the Sabellidae, but in the original description the collar was overlooked. This collar is open at the back with the ends flaring out but coming together when the worm is in a relaxed condition. There are no setae on the collar, but there are two pigment spots under it similar to the eyespots of the Oligochaeta. The ciliated branchiae are on branchial lobes which expand laterally. At the base of each branchia is a pigment spot. These can be seen only in the more mature individuals, the younger ones having fewer or none at all. I have counted up to ten on one lobe.

The pseudohemal system has a green fluid. This flows from two hearts at the base of the branchial lobes into the tentacles, then back down each side of the esophagus, uniting into a single vein which runs the length of the body ventral to the digestive tract. It flows through three pairs of loops, one pair in each of the last three segments, to a vein which forms a sheath around the digestive tract. Here it is pumped by a series of muscular contractions back to the head end of the body to begin circulation again. I failed to find the loops in any of the other segments as Dr. Leidy suggested they were.

The digestive tract is ciliated for the whole length. This seems necessary in view of the fact that the muscular contractions driving the pseudohemal fluid are from the posterior to the anterior end in opposition to the contents of the digestive tract.

The testes and ovaries are located as he described them. The female opening is between the fifth and sixth segment. In the one case where I was fortunate enough to observe the eggs being laid they measured .135 mm x .095 mm.

The setae and uncini are about as he described them except the pectinate uncini of the last three segments, which have from three to five rows, composed of six or seven teeth each.

[1] *Phil. Mag.*, 7: 493, 1929.

The specimens are on file at the American Museum of Natural History in New York City. Perhaps they have been carried to the Duluth Harbor on some of the occasional ocean-bound vessels that visit this port. At least, it is surprising to find them so far from salt water.

O. LLOYD MEEHEAN

SOME ADDITIONAL STORIES ABOUT SCIENTIFIC NAMES

DR. L. O. HOWARD'S recent note on this subject calls to mind a story regarding a bacteriological scientific name that I have intended to record before this.

In the publication of De Bary's original description of the common spore-forming organism, *Bacillus megatherium*, a typographical error occurs which has frequently caused trouble. The incorrect spelling is *Bacillus megaterium*.

Last summer in chatting with Professor S. Winogradsky in his laboratory maintained by the Pasteur Institute in the little town of Brie-Comte Robert near Paris, I learned that he was a student in De Bary's laboratory at the time he discovered this organism. He tells me that because of its large size it received the nickname in the laboratory of the "big animal." In American slang, this would have been "big bug." The correct spelling then is, as I have already indicated, *Bacillus megatherium*, and its derivation is evident. Some attempts have been made to retain the misspelled form of the word, and various students have tried to give a logical derivation for it.

Another typographical error that occurs in the naming of one of our common spore formers is found in Migula's original description of *Bacillus albolactis* in his "System der Bakterien." The form just given is the correct Latin form and occurs in the index, although the spelling in the text is given as *B. albolactus*. The incorrect spelling is frequently used in the literature.

ROBERT S. BREED

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION

REPORTS

THE NATIONAL RESEARCH COUNCIL'S GRANTS-IN-AID

AT a recent meeting of the National Research Council's Committee on Grants-in-Aid, which is composed of the chairmen of the council's seven divisions of science and technology and the chairman, treasurer and permanent secretary of the council, and which has charge of the disposition of certain funds made available to the National Research Council by the Rockefeller Foundation for the making of special grants, various matters of policy were considered and several grants were made.

The following items of general policy were adopted:

Grants will be made primarily for the support of investigations in the fields represented by the divisions of the Research Council, in order to cover the following expenses: apparatus, material, assistance and necessary travel to and from the field of operation.

In general, grants will not be given for personal salary, for expenses of publication, for the purchase of books or for travel to attend scientific meetings.

Preference will ordinarily be given to the support of investigations: (*a*) which can be completed with the aid of the grant; (*b*) toward which the university or other institution to which the applicant is attached also contributes financially or through special support; (*c*) for which a grant of not more than $1,000 is requested.

A report of progress, with items of expenditure, should be made by the grantee to the secretary of the committee at least twice a year, as of December 31 and June 30.

The title to property purchased from grants will remain with the National Research Council until ultimate disposition of the property is made by the council.

Eighteen grants were made, as follows:

Richard T. Holbrook, professor of French, University of California, for X-ray studies on speech articulation in French, Italian and other languages; Charles W. Jarvis, associate professor of physics, Ohio Wesleyan University, for studies of critical potentials of mercury vapor; Gordon L. Locher, assistant professor of physics, Miami University, for studies of the composite photoelectric action of X-rays; Paul R. Rider, associate professor of mathematics, Washington University, for a study of the mathematical theory of the reliability of random samples; George B. Welch, Marshall College, for investigations on photoelectric thresholds; Ernest V. Lawrence, associate professor of physics, University of California, for a study of the photoelectric properties of metal surfaces and thin films of alkali metals; Raymond T. Birge, professor of physics, University of California, for the purchase of an electric computing machine for use in studies on the probable values of the general physical constants, and Mark H. Liddell, professor of English, Purdue University, for studies upon the physical characteristics of speech sounds.

James B. Macelwane, S.J., professor of geophysics, St. Louis University, for seismological investigations, involving the establishment of seismological stations at Little Rock, Arkansas, and in Kentucky or Tennessee, and Willard Berry, the Johns Hopkins University, for investigations on the Tertiary fauna, especially the Foraminifera, of Peru.

Charles W. Greene, professor of physiology and pharmacology, University of Missouri, for a study of the physiology of the nervous and reflex control of the coronary circulation through the heart; R. S. Cunningham, professor of anatomy, Vanderbilt University, for investigations on the metabolism of connective tissue cells, and A. T. Rasmussen, professor of neurology, University of Minnesota, for studies of the human hypophysis.

Lee R. Dice, assistant professor of zoology, University of Michigan, for a study of the variability of deer mice, *Peromyscus maniculatum;* E. F. Chidester, professor of zoology, West Virginia University, for investigations on the endocrines of nutrition, and C. A. Barker, Ohio State University, for investigations on the biology of the Miami River near Dayton, Ohio.

Knight Dunlap, professor of experimental psychology, the Johns Hopkins University, for studies on the participation of the muscles of the human body in thought processes, and Forrest L. Dimmick, professor of experimental psychology and research associate, Hobart College, for experimental investigations of auditory experiences.

Only one of the grants so far made has exceeded $1,000 in amount, two grants of this sum having been made, one for $960, one for $600 and four for $500 each. The remaining nine grants were for sums of less than $500. Eight of the eighteen grants were made for the purchase of apparatus; one was for the purchase of supplies; six were for technical assistance, and three for travel and special services.

VERNON KELLOGG,
Permanent Secretary,
National Research Council

GRANTS FROM THE ELIZABETH THOMPSON SCIENCE FUND

PREVIOUS awards from the Elizabeth Thompson Science Fund have been reported in SCIENCE, April 23, 1926, and earlier. Since the last report the following awards have been made:

At the meeting of May 27, 1926

No. 271 to C. E. Mickel, University of Minnesota, $275 toward traveling expenses necessary to visit collections of type specimens for his study of the biology of the Mutillidae.

No. 272 to A. A. Schaeffer, University of Kansas, $200 for aid in the prosecution of his studies on the spiral movement of organisms with special reference to man.

No. 273 to Orland E. White, Brooklyn Botanic Garden, $300 toward the purchase of an eight-row calculating machine for use in working up his studies on inheritance in the genus Pisum.

At the meeting of February 25, 1927

No. 274 to B. Lipschütz, Paltauf's Pathological Institute, Vienna, Austria, $150 for experimental animals and chemical reagents for use in studies on the inclusion diseases of the skin.

No. 275 to Bela Pogeny, Budapest, Hungary, $300 for apparatus necessary for studies on the propagation of light in rotating glass.

At the meeting of November 28, 1927

No. 276 to Homer Smith, department of physiology, University of Virginia, $300 for a study on the evolutionary development of body fluids of higher animal forms.

No. 277 to J. Strohl, Zurich, Switzerland, $200 in support of the Concilium Bibliographicum.

No. 278 to E. Uhlenhuth, University of Maryland, School of Medicine, $300 for aid in conducting a series of experiments on basal metabolism as influenced by certain endocrine glands in cold-blooded animals.

At the meeting of February 6, 1928

No. 279 to E. Witschi, University of Iowa, $300 for aid in constructing an aquarium tank.

No. 280 to B. Lipschütz, Paltauf's Pathological Institute, Vienna, Austria, $150 for experimental animals and other items necessary for his investigations.

At the meeting of May 25, 1928

No. 281 to Norton A. Kent, department of physics, Boston University, one Munroe calculating machine for aid in the reduction of spectrum plates.

No. 282 to Joyet-Lavergne, Paris, France, $360 toward the purchase of a binocular microscope for use in cytological investigations.

No. 283 to H. M. Chadwell, Tufts College, $400 for the purchase of a Zeiss refractometer necessary for the completion of researches on the depression of the freezing-point.

No. 284 to A. A. Schaeffer, University of Kansas, $150 to enable him to continue two phases of his work on spiral movement.

At the meeting of November 27, 1928

No. 285 to William Rowan, University of Alberta, department of zoology, $300 as a contribution toward the cost of his experiments on migration of crows.

No. 286 to Knut Lundmark, Astronomical Observatory, Upsala, Sweden, $150 as aid to his work on spiral nebulae.

At the meeting of February 25, 1929

No. 287 to W. J. Crozier, Laboratory of General Physiology, Harvard University, $250 for furtherance of an investigation of the thermodynamic efficiency of the fixation of atmospheric nitrogen by organisms.

No. 288 to E. Witschi, University of Iowa, $200 for aid in the study of the abnormal development of over-ripe amphibian eggs.

No. 289 to T. J. Königsberger, Mathem.-Physik. Institut, Freiberg, Germany, $200 to aid in the investigation of the electrical conductivity of the earth at different depths.

The trustees of the Elizabeth Thompson Science Fund meet during the last ten days of the months of February, May and November. Applications for grants should be sent in well in advance of the meeting to the secretary of the fund, Dr. Edwin B. Wilson, 55 Van Dyke Street, Boston, Mass.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

METHOD FOR CONCENTRATING AND SECTIONING PROTOZOA

DIFFICULTY in securing sufficient concentration and satisfactory orientation of protozoa for making paraffin sections is frequently encountered. Partial control of the degree of concentration of the protozoa in one area of the block which is to be sectioned as well as a "natural" or "self-orientation" of the individuals is to be desired. By the use of the method described below the protozoa may be satisfactorily prepared for sectioning.

For the best results in the final step (sectioning) every trace of the fixative used must be removed. Iodine may be used to remove mercuric bichloride or lithium carbonate to remove picric acid if either has been employed in the fixative.[1]

It is convenient to use a vial with a wide mouth and a round bottom for the entire procedure of infiltration, as described by Wenrich.[2] The lowest fourth cut from an ordinary sized test-tube is satisfactory for the purpose. The vial is placed in a mound of molding clay or in a hollowed cork which will serve as a base. A pipette with a rather large mouth is best for removing the fluids.

Following each change of fluids the protozoa are allowed to settle to the bottom of the vial, after which the next change is made by pipetting off the fluid to within 4 mm of the level of the protozoan mass. This method requires more frequent changes of the fluids, for as in the case of alcohol, the fluid remaining each time lowers the percentage of the newly added alcohol. This gradual change, however, prevents a great loss of specimens.

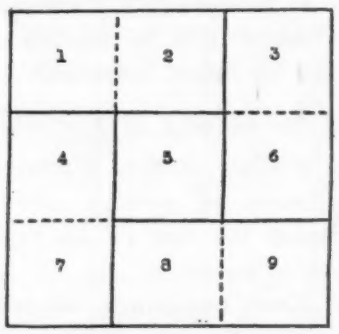

Fig. A

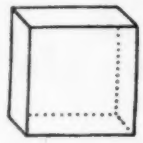

Fig. B

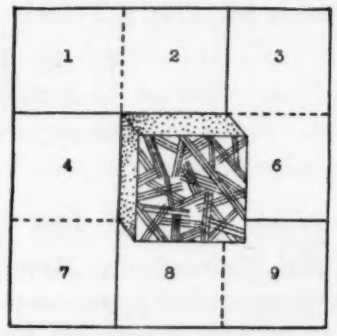

Fig. C

The protozoan mass may be carried through the entire process of dehydration and clearing in the same vial. A mixture of absolute alcohol and xylol and finally pure xylol is used to clear the specimens. After pipetting off most of the xylol, melted paraffin is quickly added. During several changes of melted paraffin the vial is kept under a heat bulb attached to a suspended light socket with a shade, to insure infiltration and complete removal of the xylol.

When infiltration is finished most of the paraffin may be removed by the use of a warm pipette, leaving only enough in the vial to cover the specimens completely. The vial is removed from under the lamp and the remaining paraffin containing the protozoa is allowed to solidify on the tip of a large dissecting needle. This is accomplished by moving the needle about gently in the mass as the paraffin cools. The result is, therefore, that the solid paraffin mass containing all the protozoa which were in the vial is now on the needle tip. This step may be referred to as the "temporary imbedding." This last step should be accomplished with the use of as little paraffin as is possible. The mass is now ready for permanent imbedding.

A small paper box of the size desired for the final block (4–10 mm) is made according to the diagram and accompanying directions and submerged in a watch crystal of melted paraffin, also under the heat bulb. The "temporary block" is now lowered into the paper box. The paraffin is allowed to melt and fuse completely with the surrounding paraffin and the specimens are allowed to settle to the bottom of the box. If the "temporary imbedding" has sufficiently concentrated the protozoa they fall from the block as it melts, into one small spot at the bottom of the box. Excess heat from the lamp will cause rapid diffusion of the protozoa and defeat the purpose. The box is lifted from the watch crystal, held long enough in the

[1] An alcoholic solution of iodine may be added drop by drop to the specimens in 70 per cent. alcohol until an amber color will persist for an hour. One drop of a saturated aqueous solution of lithium carbonate may be added to each 10 cc of alcohol containing specimens.

[2] D. H. Wenrich, "McClung's Handbook of Microscopical Technique," Hoeber, New York, 1929, p. 403.

air for the paraffin to seal to the sides and then the box with the contents is lowered into ice water.

After complete hardening, the paper may be peeled off. If the sides and corners of the box have been made in sharp creases, the block is now ready for sectioning without the usual trimming. In general, however, it is better to lose a few specimens by trimming, because accurate trimming aids in securing good serial sections. Frequently the specimens are so well concentrated that by mounting and sectioning the block at right angles to its position in the box only a small portion need be sectioned, to include all specimens. In cases where the protozoa used have one longer axis they will be likely to settle with that side against the bottom of the box, and so by orientating the block the majority of the individuals may be secured in a definite plane of section.

Concentration of both free-living and endozoic protozoa may be successfully carried out in this way.

Explanation of diagram. A square piece of paper is ruled into nine equal sized squares and cut along the dotted lines as indicated in Fig. A. Squares 7 and 8 are folded up over 4 and 5; 6 and 9 are folded to the left; then 2 and 3 are folded downward; squares 3 and 9 are then folded under the center square; the folds are next opened up and 2 and 3 are folded down over 5 and 6; 1 and 4 are folded to the right and 7 and 8 are folded upwards; the two ends, 1 and 7, are folded under the center square. If all the folds are now opened up, a box may easily be made with 1 outside of 2, 3 outside of 6, 9 outside of 8 and 7 outside of 4. The corners may be secured with gummed paper (Fig. B). This method of cutting and folding results in a box which has the four corners open at the bottom to facilitate the exchange of paraffin in the final imbedding. Fig. C shows the paraffin block secured by imbedding in this box.

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SPECIAL ARTICLES

INSULAR BIOTA AND DISPERSAL AGENTS

WORKING on a group of mites which are non-parasitic but common on vegetation, living or dead, the question of dispersal of these animals has often been brought to my attention. Sellnick[1] records two Oribatids from Krakatau. Halbert[2] records five from the Bills, sea-swept rocks off the west coast of Ireland. Praeger[3] summarizes the biota of these rock islands and endeavors to explain its origin. After suggesting every possibility that has been offered by former writers on distribution, he seeks refuge in the amplitude of another land bridge—this in spite of the fact that his collaborators have given him the clue. The majority of the animals listed were found in old nests of puffins and great black-backed gulls. These latter are builders of large nests, bringing material from the mainland.

A careful perusal of nesting habits of marine birds as brought together in the U. S. National Museum bulletins by Bent reveals that the gulls, more than any other marine birds, use considerable material for their nests which they place on islands to escape foxes (not man). This, coupled with their wide distribution and commonness, is enough to account for a great deal of transport of grasses, straws, plant material of all kinds even to sticks of wood.

Although Oribatid mites may be carried on sticks as adults, as many as thirty-three specimens representing three species having been taken from a single stick some two feet long within the limits of New York City, other larger animals may be transported on sticks, in straws and plant stems (or glued to them) *as eggs* or seeds. Many of the islands used by birds have no beach on which drift may accumulate. This necessitates carriage from the mainland—like Noah's dove. A catalogue of the spores, seeds and eggs that may be carried on nesting material will destroy a large number of land bridges. Certainly most of the hundreds of Oribatids described, many Collembolans and not a few beetles (especially wingless ones) may be carried thus as adults. Ernst[4] records gulls on Krakatau in 1906.

An extension of this type of carriage would include dispersal from place to place on land. An Oribatid traveling at the rate of an inch a minute on white paper, over a woodland or even a meadow floor may require twelve hours to advance three feet (especially if it has to crawl over a log), but a bird may carry it or its eggs thirty feet in a minute. On land, hawks, crows and squirrels are our chief distributors of dead wood. Although streams may check the latter, the first two would know but few boundaries. Vireos distribute lichen-dwellers, swallows disperse mud-dwellers, the majority of which tide over periods of desiccation in an encysted stage. The possibilities are as numerous as the habits of nest-builders, and the speed of dispersal per annum will be measured by the distance a bird will carry nesting material. The fauna of birds' nests has already been touched on by

[1] 1924, *Treubia*, 5: 371.
[2] 1915, "Clare Island Survey," pt. 39–ii, *Proc. Royal Irish Acad.*, vol. 31.
[3] 1915, *op. cit.*, pt. 68.
[4] "New Flora of the Volcanic Island of Krakatau," Cambridge University Press.

various writers but this field is barely touched as most analyses are based on old, abandoned nests when most of these litter dwellers drop to the ground as soon as their substratum becomes thoroughly desiccated. The potential fauna and flora of ungathered nesting material, then, should be the next step towards explaining origins of biota and dispersal of species of small size.

ARTHUR PAUL JACOT
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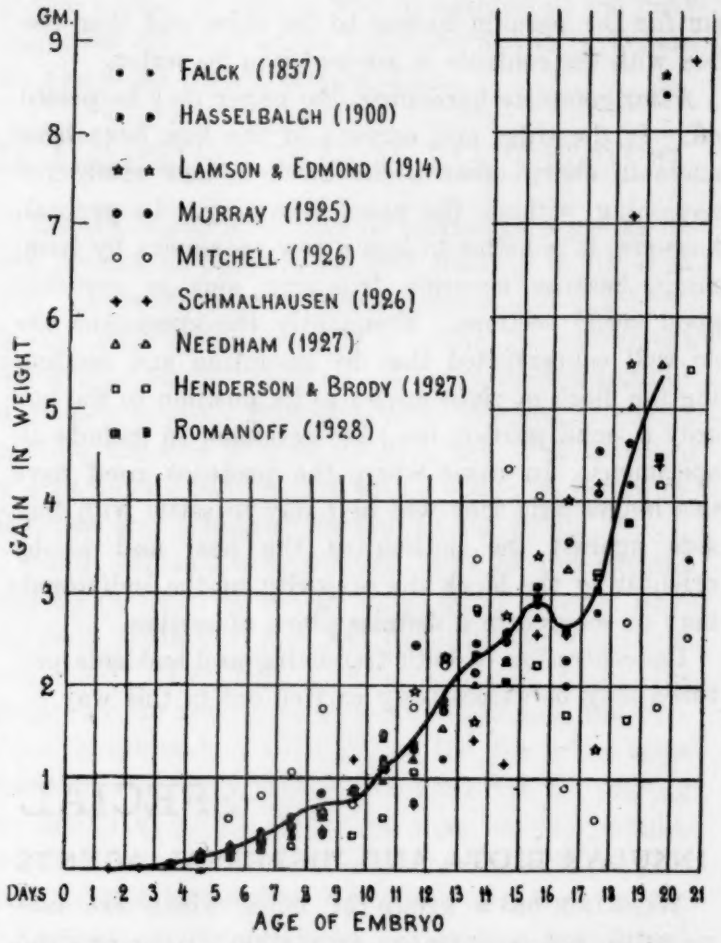
CYCLES IN THE PRENATAL GROWTH OF THE DOMESTIC FOWL

THE growth of the fowl's embryo, like the growth of mammalian embryos, of man's, for example,[1] consists of alternate periods of rapid and slow growth. These oscillations or growth-cycles are not accidental; they are easily distinguishable from accidental fluctuations, and they occur at very nearly the same places in the growth curve of every normal embryo.

This subject received very little attention in the past. The early investigations of Falck[2] and Liebermann[3] were insufficient to show the growth-cycles. Later, Hasselbalch[4] and Lamson and Edmond[5] gave more experimental data, from which Brody,[6] applying statistical methods, could demonstrate two growth-cycles. Then Murray,[7] adding his own data, concluded that there must be "three chief cycles."

Since the number of observations from which the above conclusions were made was very small,[4, 5] further study of the cycles seems to be necessary. The recent data of Mitchell,[8] Schmalhausen,[9] Needham,[10] Henderson and Brody[11] and Romanoff[12] may throw light not only on the number of cycles but on the approximate times of them in the life span of the embryo, as well.

The summarizing data on the accompanying chart of the daily gain in weight of the embryo show that:



(1) In general, the fluctuations in growth are not accidental and not the result of experimental error, but are oscillations caused by the normal chemical and physiological processes in the course of prenatal development. (2) There are at least three well-distinguished cycles in the growth of the fowl's embryo. (3) The retardation of the growth usually falls within a definite age of the embryo, that is, at nine and sixteen days of incubation.

These cycles are found to be regular only under uniform conditions of incubation, when the temperature and the humidity are accurately controlled.[13] If the conditions of incubation happen to be changed the cycles invariably occur, but the time of their occurrence will be shifted. For example, should the temperature be higher, the same cycles will appear earlier. On the other hand, should the temperature be lower, the same cycles will appear later.[11] If the conditions of incubation happen to be extremely abnormal, the cycles are not distinctly outlined, as in the case of extremely variable humidity.[12]

While there is enough evidence to believe that the growth-cycles have a pronounced influence on the physicochemical side of the embryonic development, they must have more recognition in future than they have had in the past by scientists working in the field of experimental embryology.

ALEXIS L. ROMANOFF
CORNELL UNIVERSITY

[1] T. B. Robertson, "The Chemical Basis of Growth and Senescence," viii + 389 pp., Philadelphia and London, 1923.

[2] C. Falck, cit. by W. Preyer, "Spezielle Physiologie des Embryos," xxi + 644 pp., Leipzig, 1885.

[3] L. Liebermann, *Archiv f. ges. Physiol.*, 43: 71–151, 1888.

[4] K. A. Hasselbalch, *Skand. Archiv f. Physiol.*, 10: 353–402, 1900.

[5] G. H. Lamson and H. D. Edmond, *Storrs Exp. Sta. Bul.*, 76: 219–258, 1914.

[6] S. Brody, *Jour. Gen. Physiol.*, 3: 765–770, 1920.

[7] H. A. Murray, Jr., *Jour. Gen. Physiol.*, 9: 1–37, 1925.

[8] H. H. Mitchell, T. S. Hamilton and L. E. Card, *Illinois Ann. Rept.*, 38: 77–79, 1926.

[9] I. Schmalhausen, *Archiv f. Entwick. d. Organismen*, 108: 322–387, 1926.

[10] J. Needham, *Brit. Jour. Exp. Biol.*, 4: 258–279, 1926.

[11] E. W. Henderson and S. Brody, *Missouri Agr. Exp. Sta. Res. Bul.*, 99: 3–11, 1927.

[12] A. L. Romanoff, Ph.D. Thesis, Cornell University, 1928.

[13] A. L. Romanoff, SCIENCE, 69: 197–198, 1929.

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THE CAUSES OF SPONTANEOUS COMBUSTION

A CONFERENCE to discuss the facts, clues and unknown quantities in the case regarding spontaneous combustion has been called by the National Fire Protection Association in cooperation with the U. S. Departments of Agriculture and Commerce, in Washington on November 14 and 15.

When fire gets an insidious start in a dry, well-managed place where no human being has been wandering about with matches or other fire-making materials, the usual explanation is spontaneous heating and ignition, said David J. Price, chief of the division of chemical engineering at the Department of Agriculture, in outlining the situation faced by the conference. But the usual explanation, he continued, is almost as unsatisfactory as writing down a mystery on a police blotter under the heading "unsolved," for the process which sets up spontaneous heating and ignition is still unknown.

The undetected process manages to start $20,000,000 worth of fires each year, according to insurance figures, and there is $200,000,000 more lost in fires vaguely attributed to causes unknown.

The conference is not to be limited to a few experts, Mr. Price emphasized. All who can shed light on the case or who are interested in the problem in any way are invited. The meeting will attract representatives of the railroads, marine transportation lines, manufacturing industries, the sugar industry, feed and cereal manufacturers, producers of hemp and other combustible fibers and of animal and vegetable oils, the paint and varnish industry, the fertilizer industry and insurance companies.

The problem is to discover the law of nature under which the destructive process operates and then to prevent the circumstances which make the process possible. A prominent government chemist, Dr. Charles A. Browne, holds the theory that the process is both bacterial and chemical.

Describing conditions in a haystack which catches fire, he points out that first of all bacterial action causes fermentation. This heats the hay, but not enough to cause ignition, for at 150 degrees Fahrenheit the bacterial process is mostly destroyed by heat, and 600 degrees would be necessary for ignition. His theory is that a chemical process enters the situation. The bacteria produce gases, and as the haystack is heating, the gases press out from the centers of chemical activity and form channels in the hay. When a channel reaches the surface of the stack, air rushes in suddenly, and the hot, unsaturated products are oxidized and the temperature rises to such a point that fire is readily produced.

It is hoped that the conference will start action toward an organized study of the causes and conditions that produce these presumably preventable fires, Mr. Price stated.

DETERMINATION OF THE HEIGHT OF AIRPLANES

DIFFICULTIES in the construction of apparatus for telling the height of a moving airplane were described by Lieutenant Leo P. Delsasso, U. S. Naval Reserve, physicist in the University of California at Los Angeles.

The maintenance of regular schedules by commercial fleets now requires flying in all kinds of thick weather. The ground may be out of sight, but the pilot must know his clearance. The barometer, time-honored altitude gauge, falls short of satisfaction on at least two counts. In the first place, it measures altitude from sea-level, not from the ground, and thus gives scant information in mountainous country. Furthermore, natural air-pressure conditions may change during a single flight so much that the barometer dial setting is thrown off as much as 500 feet, or in exceptional cases 1,000 feet or more.

The sound-resonance method of altitude detection, developed in the Navy some years ago by Lieutenant Delsasso and others, is regarded as the best prospect. When used in ordinary navigation, the depth of the sea-bottom is readily measured from a vessel.

If a loud, sharp sound be emitted downward from a flying airship, its return echo may easily be received and timed with proper chronometric apparatus. From the known speed of sound in air one may calculate the distance to earth. This scheme works fairly well with a lengthy craft such as the *Graf Zeppelin*, where the delicate sound receiver can be mounted far from the noise of motors. With the airplane, however, the noise of operation is so great that the pilot finds it almost impossible to analyze the echo returning from the earth. He is unable to tell which returning sound is the tell-tale signal.

Research in progress in Lieutenant Delsasso's laboratory indicates that a sound filter will solve the difficulty. A very sharp sound—preferably one generated by a whistle—is chosen to give one simple frequency of vibration, but in great amplitude or intensity. Such a selected sound is sent downward from the plane, and its echo received in apparatus adjusted to receive the least possible direct sounds from the nearby motors.

In the receiving apparatus the desired sound is built up by a suitable resonator which does not respond to the miscellaneous motor noises. The extraneous sounds may then be damped considerably without loss of the specific sound which is desired.

The use of such a sound filter and detector would have prevented a disaster like that suffered some time ago near Beaumont, California. In this accident the pilot, headed for the Colorado desert, was flying blind in a fog. He missed the San Gorgonio Pass and collided directly with the mountain barrier at one side. With proper sounding equipment he could have measured his distance to the ground below, or to possible obstructions on either side,

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THE PREVALENCE OF ILLNESS

ON an average, each person in the country has at least one disabling illness every year, the Committee on the Cost of Medical Care has reported after a survey of various sickness reports compiled by the U. S. Public Health Service and other organizations.

Men have a disabling sickness about once a year, women about twice and children over twice during the school year. Colds, bronchitis, grippe, influenza and pneumonia are oftenest the cause of these disabling illnesses and cause the longest disability. On the same basis of the number of cases and total time lost digestive disorders and diseases also take a high place.

About 130,000,000 cases of disabling illness occur in the United States each year. Adding non-disabling illnesses more than doubles the figure, the committee reported. The 36,000,000 wage earners in the country lose at least 250,000,000 work days per year, and the 24,000,000 school children lose 170,000,000 school days per year. These figures account for only one half of the total population.

"Authorities have stated that there are at all times approximately 700,000 persons with tuberculosis, 10,000 with pernicious anemia and 110,000 addicted to narcotic drugs," the report said. "In any one year there are in the United States over one million cases of malaria. Syphilis and gonorrhea at any one time appear to be causing nearly one person per 100 to place himself under the care of a physician. Over 36,000 cases of smallpox were reported in a recent year. While childbearing is not a disease, it does cause a large amount of disability. In 1928 there were nearly 2,000,000 births in the registration area, many of them followed by complications and a considerable number (a larger proportion than in most civilized countries) by death.

"Hospitals for mental and nervous diseases contain over 350,000 patients, and this figure is far below what the total would be if those not hospitalized were included. Of the children now attending school and college, 'over 960,000 will enter a hospital for mental disease at some period in their lives if present rates for first admissions continue.' These figures include only the more serious mental diseases and take no account of the large numbers with lesser mental disturbances.

"Hospitals other than those for nervous and mental diseases contain, on the average, over 350,000 patients at all times. The total in all hospitals on a single day is about 700,000."

THE DISTRIBUTION OF PHYSICIANS

AN enormous army of practitioners and assistants exists in this country for the purpose of caring for the sick people and preventing illness among the well. The actual and estimated figures, showing that more than one out of every hundred in the population are engaged in such activities, have just been compiled by the Committee on the Cost of Medical Care.

"There are in the United States more physicians per 100,000 people than in any other country in the world," the committee reported as a result of one of its surveys which showed that there are 143,000 physicians in the country.

About 1,500,000 people, enough to make a city bigger than Detroit, are employed in connection with the care and prevention of illness, the committee estimated. This figure includes physicians and their attendants, dentists with their assistants and technicians, trained and practical nurses, midwives, physiotherapists, hospital superintendents and personnel, pharmacists and drug clerks, opticians, health department and clinical laboratory personnel, chiropodists, masseurs and all the "healers," such as Christian Science practitioners, osteopaths and others.

Of these, the 550,000 workers in hospitals, exclusive of nurses, physicians and superintendents, make up the biggest group. The next largest is the group of practical and trained nurses, totaling 351,996, and the third largest comprises the 143,000 physicians.

Uneven distribution of physicians exists throughout the country, which, more than the total number, affects the sufficiency.

"In 1927 South Carolina and Montana had only 71 physicians per 100,000 people; California, at the other extreme, had 200," the report says. "Various state surveys show clearly that the larger cities are over-supplied with doctors relative to population, whereas the smaller towns and rural districts are relatively under-supplied. Comparatively few recent graduates of medical schools are located in the small communities; the proportion settling in the larger cities is becoming progressively larger."

THE MOOSE IN SWEDEN

THE moose, usually called "elk" in Europe, is rapidly increasing in Sweden, under the protection of strict game laws. This year's brief open season of four days has just drawn to a close, and preliminary reports indicate that approximately 3,500 animals were killed, as compared with 3,700 in 1928.

This protective legislation has, however, not proved wholly popular with farmers and foresters in certain parts of Sweden, because the moose is causing some damage to the crops and the young trees. Moreover, the moose, which was formerly a shy and elusive animal, has recently become extremely bold and in some cases ferocious. They are not easy to drive away from fields and gardens and in some instances they have attacked the farmers who tried to protect their crops.

The influence of civilization has also been harmful to them, as in the case of "Jeppe," a young moose that became so domesticated that it lived for years around a little village in northern Sweden. It went from house to house begging food, like a dog, and when it at last was turned back to the forest to join its wild brethren, it was unable to cope with the life in the open and was discovered shortly afterwards dead from starvation.

That even the monarch of the Swedish forests can at times bring forth abnormal specimens is shown by the

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fact that a hermaphrodite moose was killed this year in Vaester Faernebo in the province of Vestmanland. It had the shovel-shaped horns of a bull, but other characteristics were those of a female animal. Last year another strange moose, a pure albino with pink eyes, was killed in Sweden, the first in more than twenty-five years. It was later mounted and is now exhibited at the Museum of Natural History in Stockholm.

PREHISTORIC MEN IN CZECHOSLOVAKIA

RELICS of men who inhabited Czechoslovakia between 3000 B. C. and 300 A. D. have been unearthed by a joint expedition from the University of Pennsylvania Museum and the Peabody Museum of Harvard.

In the course of less than a month's preliminary search, nineteen archeological sites were uncovered, the director of the expedition, Vladimir J. Fewkes, reports. His first official statement says: "Results obtained justify a belief that many of the most important problems relating to the antiquity of mankind may be more closely approached, and possibly solved, by extensive excavations in Czechoslovakia."

The preliminary expedition worked only in the province of Bohemia. Three of the sites containing traces of early inhabitants were dated as being of the Eneolithic, of Copper Age, to 2100 B. C. and 1800 B. C., a period just before the discovery of bronze. Three graves of these people were found, and also part of a settlement where the earth still holds quantities of their pottery, bone awls and chisels, stone knives, clay spindle whorls and loom weights used in making textiles.

"A huge house pit with two fireplaces and an unusual ash pit with stone slabs for heating and pebbles for cooking also were found," Mr. Fewkes states. "These latter discoveries are of an unusual character and it is believed that a careful analysis of them will add considerable to our knowledge of the Eneolithic Age."

Eight graves of the Bronze Age, encased in limestone slabs and containing highly contracted skeletons and bronze and pottery objects, were among the expedition's discoveries. At these sites, too, were twenty-two urn burials containing cremated remains and accompanied by scores of pottery vessels and metal objects.

Remains of a settlement of the early Iron Age dating between 800 and 500 B. C. revealed several house pits and the impressions and decayed parts of some of the wooden posts that originally supported the house construction.

An urn burial from the Roman period, about the third century A. D., is pronounced representative of the true "Barbaric" or "Teutonic" culture.

The material found is to be divided between the two museums which conducted the expedition.

ITEMS

A SMALL reptile, less than a foot in length, has been found embedded in a block of soft, cannel coal, in an abandoned mine near the Ohio River near the town of Linton or Yellow Creek, long since deserted. This discovery is of such interest to geologists, especially since numerous fossil fishes and amphibians were associated in the coal with the reptile, that Western Reserve University has excavated further. Examination of many tons of coal, however, has revealed no new reptiles. Geologists regard this as unfortunate since the first skeleton lacked the head, a part which is of the greatest interest on account of the arrangement of the bones. A similar reptile of the same age has been found in France, but it likewise lacks the head. The animals were apparently adapted to swamp dwelling, the broad hind feet serving as effective paddles in the lagoons.

THE spawning grounds of the common sardine in America, long sought by fisheries men, have been discovered recently by E. C. Scofield, scientific assistant in the California State Bureau of Commercial Fisheries. Fishermen have long noted that sardines would disappear just before they were ready for spawning but could never locate their spawning grounds. Mr. Scofield made a long search, covering the entire coast of California from San Diego to Eureka, and finally found schools of sardines spawning and large numbers of their eggs and larvae five miles off Point Vincent in the southern part of California. Mr. Scofield's discovery is important from a scientific standpoint and will also be of practical benefit to the sardine canning industry. His search was sponsored by the hydrobiological survey, which is a cooperative investigation with the Hopkins Marine Laboratory of Stanford University and the State Bureau of Commercial Fisheries.

NEARLY one hundred different mammals, birds, reptiles and fish were regarded as sacred to various gods in ancient Egypt, and their bodies were mummified by thousands, Professor Roy L. Moodie has found while investigating this subject for the Field Museum of Chicago. The cost of this religious procedure was enormous. More than two hundred yards of fine linen cloth, a half yard wide, were needed for the wrapping of a single bull. As bulls were held in extreme veneration by the ancient Egyptians, great numbers of them were preserved. Expensive sarcophaguses, carvings and statuary show the further care of the African bull. Birds of the hawk and falcon type were also abundantly preserved. All of the animals mummified are known to be still living, and the mummies provide evidence that such animal species have existed over many thousand years.

LOW concentrations of ozone are not of much use in treating tuberculosis in guinea-pigs, Dr. H. B. McDonnell, of the University of Maryland, has reported to the Association of Official Agricultural Chemists. Dr. McDonnell's report was based on results of five years of work. The pigs were inoculated with tuberculosis and given ozone in concentrations ranging from one part per million to one tenth part per million. The weaker concentrations had little or no effect on either the pigs or the course of the disease. The stronger concentrations did not ameliorate the disease nor did they prolong the lives of the pigs. In fact the stronger concentrations of ozone seemed to have the opposite effect of shortening the pigs' lives.

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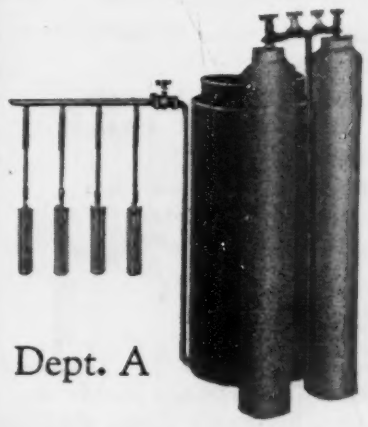

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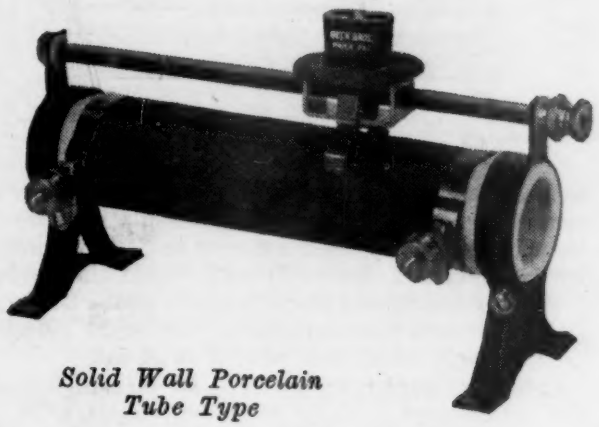

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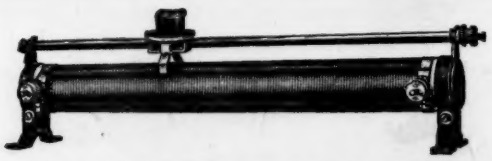

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Write for Bulletin 273

DR. ROBERT C. BURT
Manufacturing and Consulting Physicist
327 S. Michigan Ave., Pasadena, Calif.

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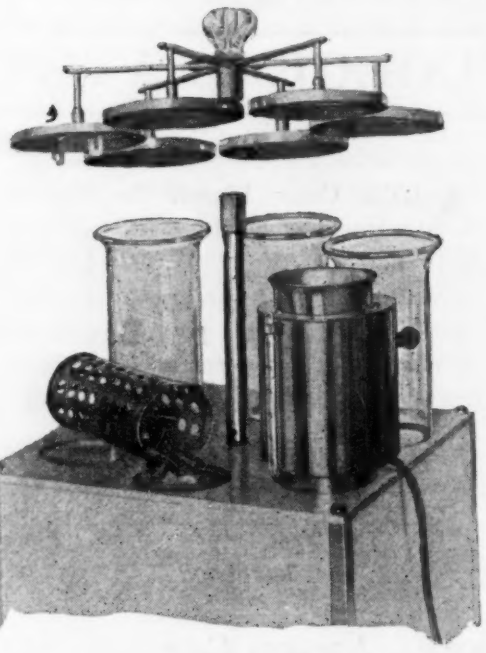
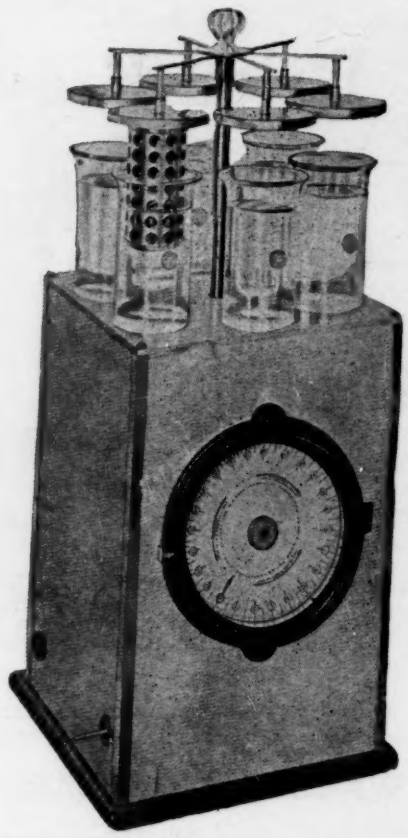
GEO. H. CONANT
RIPON, WISCONSIN

EMPIRE LAB-AID AUTOTECHNICON

(Patents Pending)

A machine by which tissues are automatically fixed, cleared, dehydrated and impregnated and by which Micro-Slides are *Deparafinized* and *Stained*





This apparatus automatically transfers tissues through fixing, dehydrating, clearing and impregnating fluids and should find many applications in Laboratories of Anatomy, Histology, Entomology, Botany, Zoology, Embryology and Animal or Plant Pathology. It is electrically motivated, is set in action by a single movement of a switch and requires no knowledge of mechanics for its operation. A special clock dial on the face of the machine enables the technicians to fix the length of time during which the tissues are to remain immersed in the various fluids. The time may be the same or different for every fluid and can be varied from 7½ minutes to 48 hours. One or more pieces of tissue are placed in perforated tissue receptacles of which about thirty can be contained in a perforated carrier which is transferred automatically from one fluid to the next.

The Special Advantages of the Machine are:

1. It constitutes a fool-proof mechanism for the fixation, dehydration, clearing and impregnation of tissues and requires absolutely no attention.
2. It does not "Forget" to change the tissues from one fluid to the next, does not leave tissues behind in one of the fluids and relieves the technicians of the time-consuming and disturbing process of transferring tissues from one fluid to the next.
3. It works day and night, Sundays and Holidays. As a result it makes it possible to save much time in the preparation of tissues for diagnosis and is of particular value for surgical specimens. By its use it is now possible to employ a long method of tissue preparation (which is considered desirable by all pathologists), yet, provides a twenty-four hour diagnostic service.
4. It makes it possible to have the tissues that are received at any time during the day, ready for blocking in paraffin early the next morning, or at any other time that the technician may desire or find convenient.
5. It can also be used to deparaffinize sections mounted on slides and pass them automatically through various fluids necessary for staining.
6. It takes but a fraction of a minute to set the machine for the desired time intervals for fixation, dehydration, etc.
7. The cost of operation is absolutely negligible.
8. There are no parts that will require replacing; the initial cost is the only cost.

An automatically temperature regulated electric paraffin bath or baths can be supplied in order to complete the impregnation in any manner desired.

Special equipment, such as a forty-eight hour clock-dial mechanism and platforms holding 12, 24 or 25 containers can also be supplied.

Illustrated descriptive booklet sent on request

Price of Standard Autotechnicon, equipped with eight day clock, twenty-four hour dial mechanism, six container platform with six pyrex containers, one monel metal receptacle carrier, twenty monel metal tissue receptacles and disc punch $275.00

Automatically regulated electric paraffin bath of finest make $75.00

Prices of other equipment to be found in illustrated booklet

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